FOREWORD

This specification consists of 10 parts. Part one covers the general requirements of the Runway Visual Range (RVR) system. Parts 2 through 10 cover requirements of each subsystem of the RVR system. The following list identifies each part of this specification.

FAA-E-2269/1b	GENERAL REQUIREMENTS
FAA-E-2269/2b	VISIBILITY SENSOR
FAA-E-2269/3b	DATA PROCESSING UNIT
FAA-E-2269/4b	AMBIENT LIGHT SENSOR
FAA-E-2269/5b	RUNWAY LIGHT INTENSITY MONITOR
FAA-E-2269/6b	REMOTE DISPLAY
FAA-E-2269/7b	CENTRAL MAINTENANCE TERMINAL/RECORDER
FAA-E-2269/8b	CENTRAL PROCESSING UNIT
FAA-E-2269/9b	REMOTE DATA COLLECTION INTERFACE
FAA-E-2269/10b	PRINTER

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CONTENTS

PART 1 - GENERAL REQUIREMENTS

CONTENTS (Cont'd.)

CONTENTS (Cont'd.)

CONTENTS (Cont'd.)

CONTENTS (Cont'd.)

CONTENTS (Cont'd.)

CONTENTS (Cont'd.)

CONTENTS (Cont'd.)

CONTENTS (Cont'd.)

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FAA-E-2269b
January 30, 1984
SUPERSEDING
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August 21, 1969

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

RUNWAY VISUAL RANGE SYSTEM SPECIFICATION

PART 1 - GENERAL REQUIREMENTS

1-1. SCOPE AND CLASSIFICATION

1-1. 1 Scope. - This specification covers the requirements for a complete Runway Visual Range (RVR) system with a capability *of* meeting Categories I, II, IIIa, and IIIb levels of flight operations. The system may include but not be limited to the following: a visibility sensor (VS), data processing unit (DPU), ambient light sensor (ALS), runway light intensity monitor (RLIM), remote display (RD), central maintenance terminal/recorder (CMT/R), central processing unit (CPU), remote data collection Interface (RDCI), printer and remote monitoring rubsystem (RMS) .

1-1.2 Classification. - The RVR system covered by this specification may include but not be limited to the following types *of* visibility sensors.

Type I — Transmissometers that are designed *to* measure and give a continuous indication of the transmissivity of the atmosphere over a selected line of sight.

Type II — Instruments that measure mattered light within a limited volume of space and that are representative of, and can be correlated to, the transmissivity of the atmosphere over a selected line of right.

Type III — Systems which are based on principles other than those described above.

1-1.3 Definitions.

1-1.3.1 U.S. definition of RVR.- The RVR has been defined as "a value normally determined by instruments located alongside and about 14 feet higher than the centerline of the runway and calibrated with reference to the sighting of high intensity runway lights or the visual contrast of other targets, whichever yields the greater visual range."

1-1.3.1.1 RVR equations.- RVR sensors may not actually measure runway visual range. Instead, they may measure either the fraction of luminous flux (t_b) that remains in a beam of light, after it has travelled a distance (b), or, alternatively, the fraction of luminous flux scattered out of the beam expressed in terms of extinction coefficient (σ). Standardized equations, based on human observations, are then used to calculate the visual range of lights or contrast markings. These equations include:

$$E_T = \frac{IT^R}{R^2}, \quad E_T = \frac{It_b^{R/b}}{R^2}, \quad \text{where, } T = t_b^{1/b}$$

Alternatively (RVR of Lights)

$$E_T = \frac{Ie^{-U-R}}{R^2}$$

And

$$\epsilon = T^R$$

Alternatively (RVR of Contrast Markings)

$$\epsilon = e^{-\sigma R}$$

Where E_T = Visual threshold of illumination

I = Intensity of runway lights (luminous intensity)

T = Transmissity of the atmosphere

t_b = Transmittance of the atmosphere over distance b (Transmissometer baseline)

R = Visual range

b = Transmissometer baseline

ϵ = Visual contrast threshold ratio

σ = Extinction coefficient

1-1.3.2 Category of operation.- All-weather instrument approach operations are divided into categories corresponding to different standards of instrumentation in the aircraft and on the ground. For each category, there is a minimum value of specified runway visual range below which operations are not permitted. The following table identifies the categories and LOWEST minima associated with each:

Category	Visibility (RVR)
Nonprecision	2,400 feet
Category I	1,800 feet
Category II	1,200 feet
Category IIIa	700 feet
Category IIIb	150 feet
Category IIIc	0

1-1.3.3 Luminous flux.- The time rate of flow of light (lumens)

1-1.3.4 Illumination.- The luminous flux incident on unit area of a surface (e.g. lumens per square meter, i.e. flux)

1-1.3.5 Luminous intensity.- The luminous flux per unit solid angle in a given direction (candelas).

1-1.3.6 Luminance.- The photometric brightness, i.e., the luminous intensity of any surface in a given direction per unit of projected area of the surface as viewed from that direction (candelas per square meter).

1-1.3.7 Luminance contrast.- The fractional difference between the luminance "b" of an object and the luminance "B" of its background [i.e. (B-b)/B, dimensionless].

1-1.3.8 Visual threshold of illumination,- The smallest illumination that can be detected by the human eye (i.e. flux)

1-1.3.9 Regular transmittance.- The term regular transmittance, as used herein, shall denote the radiant or luminous unscattered flux which remains in a beam after traversing an optical path of a given length in the atmosphere (Dimensionless; length of path has to be stated), also called "transmission coefficient."

1-1.3.10 Transmissivity.- The term transmissivity, as used herein, shall denote the regular transmittance of light through unit distance of atmosphere (Dimensionless).

1-1.3.11 Visual range.- The distance at which an object or light source can just be detected (feet or other units of length).

ϵ = Visual contrast threshold ratio

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1-1.3.11 Visual range.- The distance at which an object or light source can just be detected (feet or other units of length).

1-2.1.3 Military specification and standards,

MIL-E-17555G	Electronic and Electrical Equipment and Associated Repair Parts; Preparation and Delivery of
MIL-STD-454	Standard General Requirements for Electronic Equipment
MIL-STD-461/462	Electromagnetic Interference Characteristics
MIL-STD-470	Maintainability Program Requirements for Systems and Equipment
MIL-STD-471	Maintainability Demonstration
MIL-STD-483	Configuration Management Practices for Systems, Equipment, Munitions, and Computer Programs
MIL-STD-781b	Reliability Test Exponential Distribution
MIL-STD-785b	Reliability Program for Systems and Equipment
MIL-STD-810c	Environmental Test Methods
MIL-STD-1521	Technical Reviews and Audits for Systems, Equipment, and Computer Programs
MIL-STD-2068	Reliability Development Tests

1-2.1.4 Military publications.-

MIL-HDBK-217	Reliability Stress and Failure Rate Data for Electronic Equipment
MIL-HDBK-472	Maintainability Predictions
MIL-I-45208A	Inspection System Requirements

1-2.1.5 Other publications.- The following FAA, National Fire Protection Association, and American National Standards Institute documents form a part of this specification and are applicable to the extent specified herein.

NAS-MD-790	Interface Control Document for the Remote Maintenance Monitoring System (RMMS)(Level I ICD)
NAS-MD-791	Guidelines for the Development of Level II Interface Control Documents for Remote Maintenance Monitoring System (RMMS)
NAS-MD-792	Operational Requirements for the Remote Maintanance Monitoring System (RMMS).
Order AF 6000.10	Airway Facilities Service Maintenance Program
Order 1800.8	National Airspace System Configuration Management
NFPA-78	National Electrical Code
ANSI X3.4	Code for Information Interchange (ASCII)
ANSI X3.66	American National Standard for Advanced Data Communication Control Procedures (ADCCP)
IEEE	Lighting Protection Standard

(Copies of this specification and other applicable FAA specifications, standards, and NAS-MD-790 may be obtained from the Federal Aviation Administration, 800 Independence Avenue, S.W., Washington, D.C. 20591, Attention: Contracting Officer. Requests should fully identify material desired, i.e., specification, standard, and amendment numbers and dates. Requests should cite the contract number or other use to be made of the requested material.)

(Single copies of the Military specifications and standards may be obtained from the Federal Aviation Administration, 800 Independence Avenue, S.W., Washington, D.C. 20591, Attention: Contracting Officer. Requests should cite the invitation for bids, request for proposals, or contract involved. Note that mail requests, if found acceptable, will be forwarded to a Military supply depot for filling; hence, ample time should be allowed.)

(Copies of the National Fire Codes may be obtained from the National Fire Protection Association, 470 Atlantic Avenue, Boston, MA 02210.)

(Copies of the ANSI X3.4 standard may be obtained from the American National Standards Institute, 1430 Broadway, New York, NY 10018.)

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1-3.2.1.3 Report values.- The RVR system report values and breakpoints shall be as, follows:

Reporting Value (feet)	Breakpoint (feet)	Reporting Value (feet)	Breakpoint (feet)
100		2000	
	150		2100
200		2200	
	250		2300
300		2400	
	350		2500
400		2600	
	450		2700
500		2800	
	550		2900
600		3000	
	650		3250
700		3500	
	750		3750
800		4000	
	900		4250
1000		4500	
	1100		4750
1200		5000	
	1300		5250
1400		5500	
	1500		5750
1600		6000	
	1700		6250
1800		6000 +	
	1900		

1-3.2.1.4 System accuracy.- Errors from all sources (including calibration stability errors) shall cause the RVR system to have an accuracy of not greater than ± 10 percent of the RVR value (root-mean-square equivalent). By "root- mean-square equivalent" is meant the equivalent 90-percent confidence level of a normal error distribution having a standard deviation of 10 percent. The 90 percent confidence level corresponds to 1.65 times the standard deviation or a 16.5 percent error. Thus the calculated RVR value must agree with a standard measurement to within 16.5 percent accuracy at least 90 percent of the time. It must also agree to within a factor of two 99 percent of the time. The system stability in a 90 day interval shall not cause an RVR system error of more than 10 percent for the most sensitive reporting value.

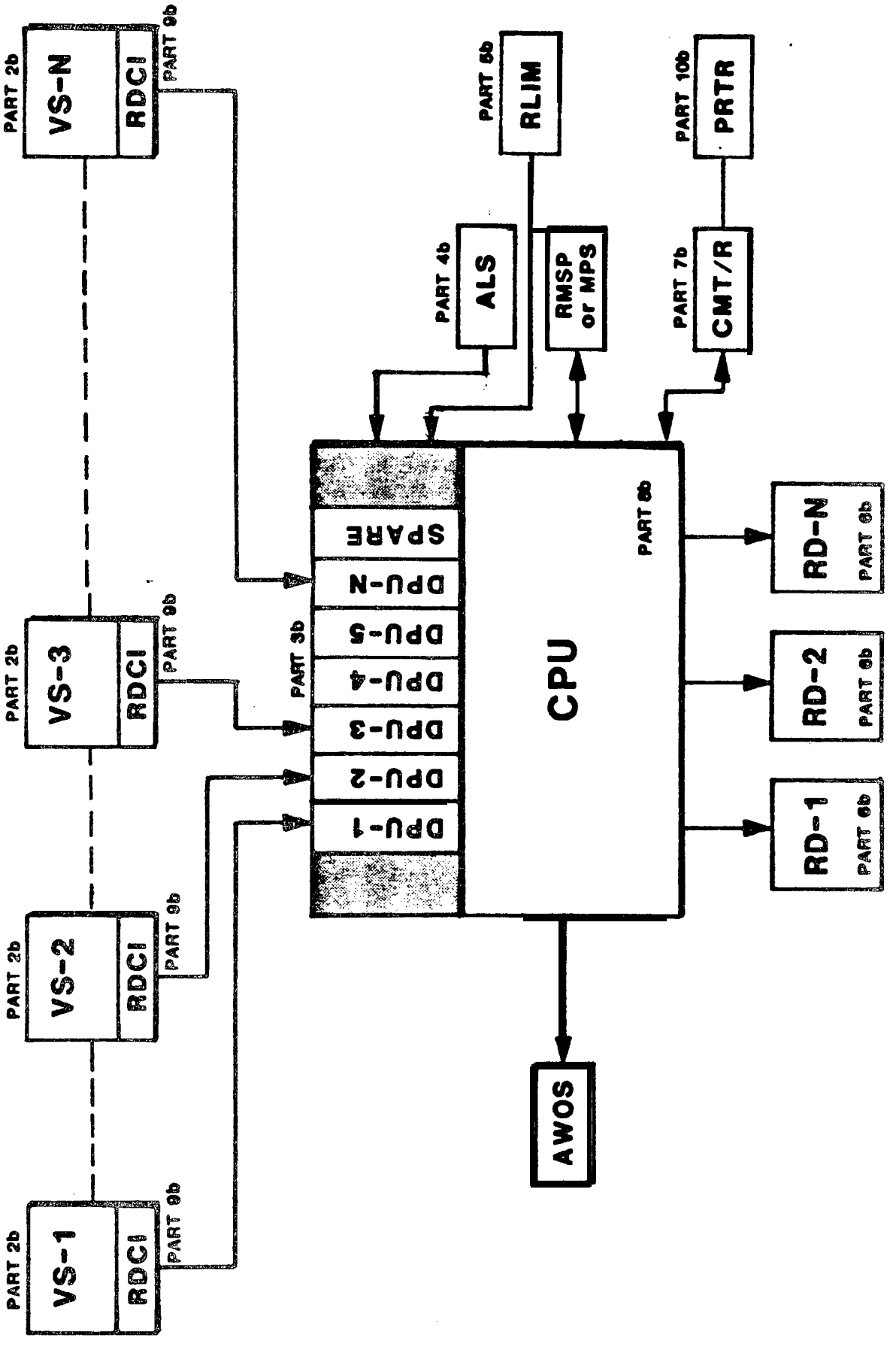

Figure 1-1 RVR SYSTEM CONCEPT

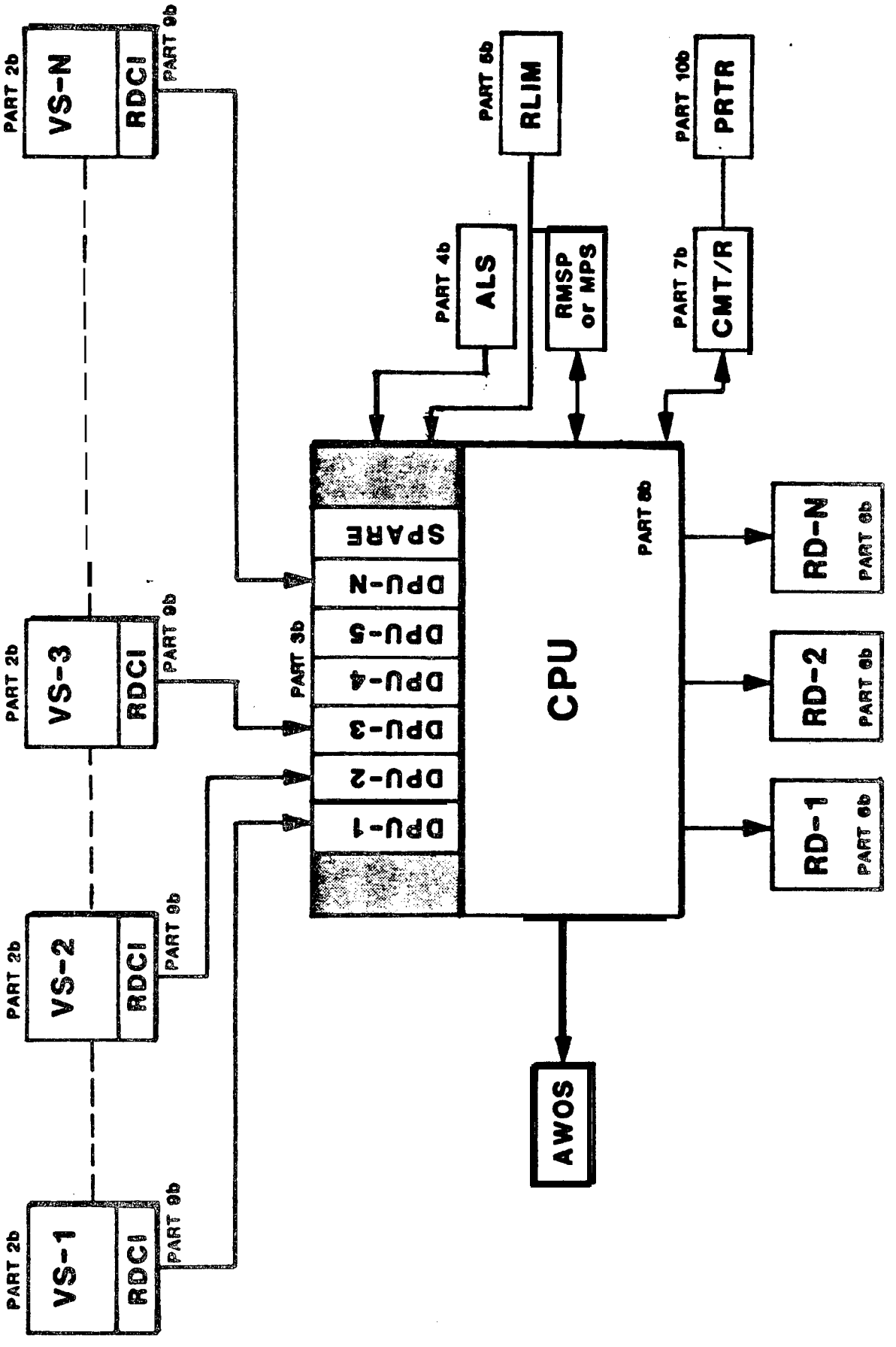

Figure 1-1 RVR SYSTEM CONCEPT

1-3.2.2 Physical characteristics.- The equipment shall reflect the optimum in simplicity, reliability, maintainability, energy efficiency, weight, and ease of installation that is consistent with maximum safety to personnel while installing, operating, and maintaining the equipment.

1-3.2.2.1 System concept.- The RVR system concept is shown in Figure 1-1 on page 1-9a.

1-3.2.2.2 System configuration.- The RVR system shall be capable of many different configurations. The following lists the minimum, standard, and maximum configurations:

RVR Subsystems	Minimum	Standard	Maximum
VS with RDCI	1 each	3 each	12 each
ALS	1	1	1
RLIM	1	1	4
DPU	2	4	12
CPU*	1	1	1
CMT/R	1	1	1
RD	3	5 to 9	15
Printer	1	1	1
RMS	1	1	1

* NOTE: All the CPUs for any system configuration shall accept 4 DPU's and shall be expandable up to the maximum system configuration of 12 DPU's.

1-3.2.3 Power and environmental characteristics.- The following power and environmental requirements shall apply.

1-3.2.3.1 Power source.- The RVR system shall operate in accordance with specifications contained herein from a single-phase two-wire AC line power source. The design center voltage-shall be 120 volts, 60Hz in accordance with FAA-G-2100c, paragraph 3.2.10. The equipment shall operate within specifications for any combination of line frequency and line voltage in the range 102-138 V, 57-63 Hz.

1-3.2.3.2 Environmental conditions.- The subsystems shall be designed to operate under the following ambient environmental conditions in accordance with FAA-G-2100c, paragraph 3.2.15:

(a) Data Processing Unit, Environment I

(b) Remote Display, Environment I

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DPU	2	4	12
CPU*	1	1	1
CMT/R	1	1	1
RD	3	5 to 9	15
Printer	1	1	1
RMS	1	1	1

* NOTE: All the CPUs for any system configuration shall accept 4 DPU's and shall be expandable up to the maximum system configuration of 12 DPU's.

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(a) Data Processing Unit, Environment I

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1-3.2.5 System calibration.- The contractor shall include a procedure within his documentation and test plan that will result in the recalibration of the system after installation in the field. This calibration procedure shall result in the determination that all elements of the system are functioning properly, and within accuracy tolerances. A method of calibration traceable to an FAA transmissometer standard must be provided. A minimum of three calibration points must be checked; zero signal, midrange signal, and maximum signal.

1-3.3 Design and construction.- The RVR system shall be designed and constructed to operate continuously and unattended with high reliability. It shall be modular in design.

1-3.3.1 Modularity.- The components and assemblies of the RVR system shall be separated into physically and functionally distinct groups or entities. The interface must be standardized such that a unit may be replaced without requiring rescaling or recalibration.

1-3.3.1.1 Modularity and configuration flexibility.- The concept of modularity permits the RVR system to be deployed in a variety of configurations to meet unique site-specific requirements, usually by adding or substituting sensors, output devices, or output circuitry.

The modular nature of the system shall allow for its ready adaptation of different requirements from a one sensor system at a small airport, a three sensor system for airports with a fully instrumented runway through a major hub requiring up to 12 sensors to instrument its runways.

1-3.3.1.2 Modularity and expansion.- Modular design techniques provide for future expansion capabilities. The CPU shall be capable of being expanded to accept up to 12 DPUs.

1-3.3.1.3 Modularity and maintainability.- A modular RVR system facilitates fault isolation, as well as faulty component removal and replacement, thus providing the simplicity that results in lower maintenance costs through a need for lower maintenance personnel skill levels, reduced training of maintenance personnel, and a smaller number of replaceable items.

1-3.3.2 Design for maintainability.- Maintainability and repair philosophies shall be in accordance with FAA Order AF 6000.10, "Airway Facilities Service Maintenance Program" dated 6/3/82, and the following:

(a) The sensors shall be designed and constructed for module onsite replacement maintenance.

(b) All electronic and mechanical equipment and components shall be designed and constructed for module onsite replacement maintenance, The maintenance philosophy shall be removal and replacement of failed sensors or sensor subassemblies and removal and replacement of failed modules in the remainder of the system. Actual repair of the failed item (module, sensor, etc.) is to be accomplished later in a separate maintenance area.

(c) The DPU, ALS, RLIM, RD, CMT/R, CPU, and RDCI shall contain functional modules or printed circuit assemblies to facilitate rapid replacement.

(d) The use of captive and rapid-action type fasteners shall be employed throughout the equipment design and standardized to facilitate rapid interchange of failed items in accordance with FAA-G-2100, paragraph 3.5. 10.

(e) Each assembly shall be removable from the cabinets without requiring the partial or complete removal of any other subassembly.

1-3.3.3 Hardware requirements.

1-3.3.3.1 General.- The CPU shall be designed to fit a standard equipment rack. Rack-mounted units shall be provided with slides, to permit withdrawal for servicing; and where components or test points are only accessible from the bottom, a suitable tilt or hinge arrangement shall be provided to permit accessibility in accordance with FAA-G-2100c, paragraphs 3.3.1.1 and 3.3.3.3. The hardware shall be designed so that all alignments, adjustments, and maintenance can be performed by only one technician. All cables and wires, harnessed or single, shall be protected against chaffing; and such protection shall be independent of the individual wire or cable insulation jacket.

1-3.3.3.2 Solid-state design,- All electronic devices (except displays) shall be semiconductor or microelectronic devices in accordance with FAA-G-2100c, paragraph 3.5.20. Digital circuit designs shall be used in preference to analog designs. Each assembly or subassembly shall provide a complete circuit function(s) with readily accessible test points. Care shall be exercised to assure that the circuits are reliable and utilize the best heat transfer techniques available.

1-3.3.3.3 Printed circuit boards.- All printed circuit boards and circuit card assemblies used shall be of the plug-in card type in accordance with FAA-G-2100c, paragraph 3.5.23 and shall be identified and keyed to prevent incorrect insertion. One printed circuit

board/card extender of each type and size used at a location shall be furnished with each complete set of equipment. One extender cable for each type of module used shall also be furnished with each complete set of equipment.

1-3.3.3.4 Power indicators and circuit breakers.- Circuit breakers used shall be placed in a convenient serviceable location in accordance with FAA-G-2100c, paragraph 3.5.12. Indicator lamps shall be provided on the front of each cabinet to display power on/off condition in accordance with FAA-G-2100c, paragraph 3.5.17.

1-3.3.3.5 System grounding.- A common system grounding design criterion shall be used for each subsystem. The Root-Mean-Square leakage current resulting from electrical line filters connected from phase to ground shall be limited to one milliampere per phase for each nonisolated input to the equipment. The grounding system design must ensure the safety of maintenance personnel when operating or testing the system, and the design must be compatible with other equipment which interfaces with this system. All surfaces of items on the front of panels shall be at chassis-ground potential. The grounding design shall be in accordance with FAA-STD-020, paragraph 4 and 5. The power ground will be available at each AC power distribution point provided in the equipment area. There shall be no degradation of signals between equipment due to cross-coupling through the ground system. Optical isolation shall be used with all digital interfaces between separated subsystems.

1-3.3.3.5.1 Lightning Protection Requirements.- All equipment and structures designed for exterior installation shall be protected against lightning strikes in accordance with NFPA-78 and as specified herein. Protection shall include air terminals, roof or platform conductors, mechanical protection for down conductors, ground rods, main size counterpoise cable, and all attachments, mounting, and bonding hardware.

1-3.3.3.5.1.1 Materials.- All materials shall be UL Listed and approved for the purpose. Air terminals shall have blunt points. All below grade connections shall be Cadweld, Thermoweld, or equivalent. Ground rods shall be copper clad steel, 10 feet long, 3/4 inch diameter, and sectionalized for extension. Aluminum materials shall not be provided unless specifically approved. Conductors above and below grade level shall be protected in Schedule 80 PVC pipe.

1-3.3.3.5.1.2 Design.- Lightning protection designs for equipment and structures shall be submitted for Government review and approval. Design changes required by the Government shall be incorporated.

1-3.3.3.6 Conducted and radiated interference.- The equipment specified herein shall be designed to operate in a complex electromagnetic environment without degradation due to interference

from other equipment and without degrading the operation of other equipment.

1-3.3.3.6.1 Interference control design.- The requirements given by other paragraphs in the specification and covering the subjects of lightning protection; transient and surge protection; and grounding, bonding, and shielding requirements are a part of or directly related to interference control design and shall be incorporated by the Contractor. In addition, the Contractor shall incorporate filtering, suppression, compartmentalization, segregation, isolation, grounding, bonding, shielding, and state-of-the-art circuit and equipment design.

1-3.3.3.6.2 Interference control program.- The Contractor's Interference Control Program shall be in accordance with MIL-STD-461 and MIL-STD-462, including revisions and notices in effect at the time of Contract Award.

1-3.3.3.6.3 Testing.- All systems, subsystems, equipment and end items shall meet the test requirements and limits of MIL-STD-461 and MIL-STD-462. Testing shall be performed by the Contractor using approved test plans and procedures.

1-3.3.3.6.4 Documentation.- The Contractor shall prepare and submit EMI Control Program Plans, EMI Test Plans, Test Procedures, and Test Reports for compliance with MIL-STD-461 and MIL-STD-462. Revisions or changes requested by the Government shall be incorporated.

1-3.3.3.7 Cable entrance and exit locations.- Cable entrances and exits shall be designed to enable routing of the cables between units from the standpoint of accessibility, noninterference with operating personnel, and appearance of installed equipment.

1-3.3.3.8 Components and materials,- All subassemblies, components, and materials shall be in accordance with FAA-G-2100c, paragraph 3.4, unless otherwise approved by the Contracting Officer.

1-3.3.3.9 Safety.-, To promote maximum safety of both operating and maintenance personnel, the precautions outlined in Requirement 1 of MIL-STD-454 shall be adhered to in the area of system design and construction.

1-3.3.3.10 Human engineering.- Human engineering design criteria and principles shall be applied in the design to achieve safe, reliable, and effective performance by operator and maintenance personnel and to minimize personnel skill and training time in accordance with FAA-G-2100c, paragraph 3.3.1.6.

1-3.3.3.11 Motors.- Motors shall be designed for continuous duty and shall have bearings that do not require lubrication more often than once every 8,000 hours of operation in accordance with FAA-G-2100c, paragraph 3.5.21.

from other equipment and without degrading the operation of other equipment.

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1-3.3.3.11 Motors.- Motors shall be designed for continuous duty and shall have bearings that do not require lubrication more often than once every 8,000 hours of operation in accordance with FAA-G-2100c, paragraph 3.5.21.

1-3.5 Documentation.

1-3.5.1 General.- The contractor shall be responsible for providing the documentation necessary to describe the installation; operation, maintenance, operational and maintenance training, and supply support for the entire RVR system and each subsystem described in other parts of this specification.

1-3.5.2 Submission.

(a) Manuals - Manuals shall be submitted in accordance with FAA-D-2494/1a.

(b) Plans - Plans shall be submitted in accordance with instructions in part 1 of this specification.

1-3.5.3 Documentation required.- The documents shall be prepared in accordance with the requirements established in FAA-D-2494/1a. One reproducible (camera ready) copy of each document shall be provided in accordance with FAA-D-2494/2a.

1-3.5.3.1 Operations manuals.- The operating instructions shall contain a complete, step-by-step description of all operating procedures. These procedures shall be in sufficient detail to provide an operator (who has no formal RVR training) with the expertise necessary to perform each operational function.

1-3.5.3.2 Maintenance manuals.- The maintenance instructions shall contain a complete description of:

(a) All maintenance procedures and adjustments performed periodically to calibrate and prevent failure of any part of the system (preventative maintenance). The procedures shall include the time allocated to each operation during each scheduled maintenance visit.

(b) All maintenance procedures and actions performed by a maintenance technician to diagnose (locate) any fault in the system and then to repair, adjust, and calibrate the equipment to meet the standards in this specification. Maintenance instructions shall be in sufficient detail to permit an FAA maintenance technician with RVR training to accomplish all field- and depot-level maintenance actions.

1-3.5.3.3 Installation and checkout manual.- The contractor shall provide step-by-step instructions for the installation and checkout of the RVR system. The instructions shall, as a minimum, include

1-3.5 Documentation.

1-3.5.1 General.- The contractor shall be responsible for providing the documentation necessary to describe the installation; operation, maintenance, operational and maintenance training, and supply support for the entire RVR system and each subsystem described in other parts of this specification.

1-3.5.2 Submission.

(a) Manuals - Manuals shall be submitted in accordance with FAA-D-2494/1a.

(b) Plans - Plans shall be submitted in accordance with instructions in part 1 of this specification.

1-3.5.3 Documentation required.- The documents shall be prepared in accordance with the requirements established in FAA-D-2494/1a. One reproducible (camera ready) copy of each document shall be provided in accordance with FAA-D-2494/2a.

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(b) All maintenance procedures and actions performed by a maintenance technician to diagnose (locate) any fault in the system and then to repair, adjust, and calibrate the equipment to meet the standards in this specification. Maintenance instructions shall be in sufficient detail to permit an FAA maintenance technician with RVR training to accomplish all field- and depot-level maintenance actions.

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(g) Software Support Data Manual - Additional text and illustrations shall be provided as necessary to provide a complete and comprehensive understanding of the equipment software. Logic and timing functions shall be fully illustrated and described. Interface with other computer systems shall be described in detail.

1.3.5.3.6 Quality assurance plan.- The quality assurance plan shall be prepared in accordance with FAA-STD-013A and submitted to the Government as specified in the contract. See 1-4. of this specification.

1-3.5.3.7 Reliability program plan.- The reliability program plan shall be prepared in accordance with MIL-STD-785B and submitted to the Government as specified in the contract. See 1-3.7 and 1-4. of this specification.

1-3.5.3.8 Maintainability program plan.- The maintainability program plan shall be prepared in accordance with MIL-STD-470 and submitted to the Government as specified in the contract. Each maintenance task shall contain the maintenance man-hours estimated to complete that task. See 1-3.7 and 1-4. of this specification.

1-3.5.3.9 Test plan.- The overall system test plan shall be prepared by the contractor and submitted to the Government for approval as specified in the contract. The Government reserves the right to require any additional testing determined necessary.

1-3.6 Interchangeability.- Components of the RVR system shall be interchangeable.An interchangeable item is one which possesses such functional and physical characteristics as to be equivalent in performance, reliability, and maintainability to another item of similar or identical purposes and is capable of being exchanged for the other item without selection for fit or performance and without alteration of the items themselves or of adjoining items.

1-3.7 Reliability/maintainability.

1-3.7.1 General.- This section of the specification covers the general reliability and maintainability (R&M) program and testing requirements. Program requirements include applicable paragraphs of MIL-STD-785B and MIL-STD-470and MIL-STD-2068(AS). Testing requirements include the application of tests necessary to assure acceptable levels of system R&M.

1-3.7.1.1 Definitions applicable to reliability and maintainability.- The following terms have specific meanings in the context of reliability and maintainability.

(a) Diagnostics - Test features, which are an integral part of the system, used to detect failed lowest replaceable units within the system.

(b) Inherent availability - Inherent availability is the probability of the system operating as specified at any instant in time over its service life. Inherent availability, A, shall be calculated as follows:

$$A = \frac{MTBF}{MTBF + MDT}$$

(c) Failure - Failure is the inability of any part, assembly, or subassembly to perform the functions for which it was designed within its specified design limits.

(d) Relevant failures - All failures are relevant until demonstrated by the contractor to be nonrelevant to the satisfaction of the Government.

(e) Mean time between failures (MTBF) - MTBF is equal to the total operating hours of the equipment divided by the number of failures.

(f) Mean Down Time (MDT)- The average out of service time for a given period of the system's service life. This time includes all system repair time and downtime required for preventive maintenance.

(g) Reliability - The probability that an item will actually perform its intended function for a specified interval under stated conditions.

(h) Predicted reliability - The reliability of an equipment mathematically computed from its design' considerations and from the reliability of its parts in the intended use.

(i) Mean Bench Repair Time (MBRT) - MBRT is the average length of time to repair an LRU. This time includes failed component isolation time, component replacement time, and time required to verify the LRU is operational.

(j) Lowest Replaceable Unit (LRU) - An LRU is a unit (component, element, module, etc.), that must be replaced to restore a failed system or system function.

(k) Repair time - The time required to isolate and replace the failed item and verify proper operation of the system, subsystem, assembly or subassembly.

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(k) Repair time - The time required to isolate and replace the failed item and verify proper operation of the system, subsystem, assembly or subassembly.

1-3.7.2.4 System diagnostics.- Systems diagnostics procedures shall be developed that are capable of identifying 85 percent of the system failures.

1-3.7.3 Reliability program.

1-3.7.3.1 Reliability program plan.- The contractor shall prepare and submit within the technical proposal a reliability program plan. The reliability program plan shall delineate how the requirements in 1-3.7.2 (MTBF) will be met. The plan shall be based on MIL-STD-785B (Task 101) and this specification. The program plan shall be updated and submitted for approval after the award of the contract.

1-3.7.3.2 Program review.- The provisions of MIL-STD-785B (Task 103) apply. Major reliability program checkpoints or milestones on both activities and results (as they become available) shall be defined and integrated into overall system program control procedures. The contractor shall establish formal program reviews, to include the preliminary and final design reviews for the Government. The reliability program reviews shall be conducted wherever possible in conjunction with other planned reviews. The Contracting Officer shall be notified at least 15 working days prior to each contractually scheduled formal reliability program review to permit participation by the Contracting Officer. The minutes of these formal reliability program reviews shall be provided to the Contracting Officer.

1-3.7.3.3 Production degradation control.- A comprehensive program shall be instituted to prevent degradation of reliability during production in accordance with MIL-STD-785B (Task 304).

1-3.7.3.4 Failure reporting, analysis, corrective action systems (FRACAS) and data collection.- The contractor shall establish and implement a closed-loop procedure in accordance with MIL-STD-785B (Task 104) to: (1) collect data on failures occurring during all phases of his effort, including incoming part inspections, component engineering and debugging, production screening or bum-in tests, and reliability acceptance tests; (2) statistically analyze the data to identify reliability problems and to assess the progress made in meeting reliability requirements; (3) perform engineering analyses of failed parts to ascertain the causes of the failures; (4) implement appropriate corrective action to preclude the recurrence of failures experienced; (5) perform follow-on audits as necessary to assure adequacy of corrective action. All data shall be available for Contracting Officer inspection. When major components of the system become available, the contractor shall implement a failure data collection system. The failure data collection system shall be approved by the Contracting Officer. As the system nears the operational inventory phase, transition to inservice failure reporting can be accomplished with minimum disturbance and maximum continuity of data,

1-3.7.3.5 Failure summaries.- Monthly summaries of failures shall be submitted to the Contracting Officer during all phases of testing (MIL-STD-785B, Task 104). They shall include: identification of each failure analysis report, equipment failure modes and cause of failure, corrective action recommended, status of corrective action implementation, and relevancy related to reliability demonstration test failures. The summaries shall be reported with an analysis showing trends, patterns, etc., that can be discerned.

1-3.7.3.6 Production reliability test plan.- Production reliability testing (MIL-STD-785B, Task 302) shall include the tests specified in this specification. A preliminary test plan shall be submitted with the technical proposal and a final plan submitted for Government approval prior to start of testing. The final plan shall be prepared in accordance with this specification and shall include the following information as a minimum for each test:

(a) Summary description of how the test is to be performed, including operating modes.

(b) Test procedures.

(c) Test duration.

(d) Criteria for test failures or success.

(e) Facilities/test equipment required.

(f) Corrective action in the event of failure.

(g) Operating environment and cyclic conditions.

(h) Plans for test results documentation.

(i) Preventive maintenance requirements.

1-3.7.4 Maintainability program.- The contractor shall provide and maintain a maintainability program that will demonstrate the maintainability objectives (MTTR, 1-3.7.2) of this specification. The maintainability program plan will be submitted to the Government after contract award. The maintainability program will use information developed under the reliability program (e.g., program review, FRACAS, failure summaries, etc.) to assist in documentation of maintainability. In addition, maintainability tests on the RVR system (and each subsystem) shall be accomplished in accordance with this specification.

1-3.7.5 Design reviews.- The reliability and maintainability programs shall be periodically reviewed during the life of the contract to identify problems which limit the reliability and maintainability of the RVR system (MIL-STD-785B, Task 203). The contractor shall accomplish all changes in equipment design that are necessary to satisfy

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relays, plug-in crystals, ferrule-type resistors, air filters, and any other parts which are used in the equipment and which are similarly designed for quick removal and replacement.

1-3.8.4 Derating of electronic parts and materials.- Derating of electronic parts and materials shall be in accordance with MIL-STD-454, Requirement 18.

1-3.9 Finishes.- Metal surfaces shall be given a protective finish as specified in the following subparagraphs and in accordance with FAA-G-2100c, paragraph 3.7.7.

1-3.9.1 Front surfaces of exterior metallic surfaces.- The front face and edges of exterior front panels and panel doors, and the exterior surfaces of equipment cabinets, portable cabinets, and all other final metallic enclosures, including the doors thereof and exterior trim strips, shall be finished by applying one or more uniform spray coats of a baking primer, followed by application of one or more uniform spray coats of a hard lusterless alkyd baking enamel in accordance with FAA-G-2100c, paragraph 3.7.7.1.

1-3.9.2 Back surfaces of exterior.- Exterior front panels and panel doors finished as specified in 1-3.9.1 above shall have their back surfaces finished in one of the following ways: same as front surface, with a baked primer (only) which is the same color as the front surface, or as specified in 1-3.9.3 below for interior aluminum surfaces.

1-3.9.3 Interior aluminum surfaces.- The chassis, interior panels, and other interior surfaces of aluminum and aluminum alloy (except castings) shall be thoroughly cleaned by an alkaline dip, or equivalent process, so as to produce an etched surface. After etching, an additional treatment which will protect the surface from finger-marks shall be applied.

1-3.9.4 Other interior metal surfaces.- All interior metal surfaces of the equipment structure (other than stainless steel and monel) not covered under the above paragraphs shall be protected by a durable coating of enamel or by a protective electroplating. Interior aluminum and aluminum alloy castings may be finished as specified in 1-3.9.3 above or this paragraph or may be left unfinished.

1-3.9.5 Plated finishes.- Where electroplating is employed as a finish, it shall be equal to the best commercial grade, using plating thickness adequate for protection of the parts under conditions of their use in service. Flash platings, platings with base metals or underplatings showing through, or platings which are pitted or give evidence of flaking or peeling are not acceptable.

1-3.9.5.1 Cadmium plating.- Cadmium plating shall not be used if it is in direct contact with, or located in confined spaces adjacent to, waxes, phenolics, or other organic materials which will react with the cadmium to cause "growth" or the formation of cadmium soaps.

1-3.9.5.2 RF conductivity platings.- Where required because of considerations of conductivity, silver, gold, or rhodium electroplating may be used. If silver plating is used, the plating process shall be such as to insure a minimum thickness of 0.0005 inch. In addition and except as noted below, the silver plating shall be given a clear chromate conversion coating for solderability and tarnish resistance. The chromate conversion coating shall be omitted on silver- plated surfaces where contact requirements are such that an increase of 15 percent in surface contact resistance cannot be tolerated.

1-3.10 Ventilation and cooling.- Forced ventilation systems shall not be used, unless otherwise approved by the Contracting Officer.

1-3.11 Reference designations.- Reference designations shall be assigned in accordance with FAA-G-2100c, paragraph 3.8.

1-3.12 · Marking.- Marking shall be as specified in the following subparagraphs and in accordance with FAA-G-2100C, paragraph 3.8 and paragraph 3.9.

1-3.12.1 Permanency and legibility.- All markings shall be permanent and legible.

1-3.12.2 Visibility of parts labels.- All parts which have labels or markings carrying identifying data or ratings should be mounted so that the data are visible to maintenance personnel without the necessity for disassembly of the part or adjacent functional or structural parts. This requirement shall be mandatory whenever it can be applied by the contractor without purchasing made- to-order parts with special markings and where it can be applied without preventing the use of normally compact assemblies of parts on chassis, such as side-by-side mounting of metalcased capacitors or other normal methods of assembly.

1-3.12.3 Cable connectors.- All cable connectors furnished on the equipment for the purpose of making external connections shall be clearly identified on the plug-in side by word labels descriptive of their specific function. Cable connectors shall be mechanically keyed to prevent incorrect installation and hookup. The mating connector part (connector or plug) that is electrically energized shall contain female contacts.

1-3.12.4 Ferrule-resistor positions.- All ferrule-resistor positions shall be marked to indicate the ohmic value of the resistor required for the particular position or mounting.

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through, or available through access holes therein. All markings shall be located on the panel or chassis in correct relationship to the respective designated items.

1-3.12.11 Other electrical parts.- On subminiaturized assemblies, transistors, integrated circuits, printed boards or other forms of assembly where space is at a premium, the reference designation need not be marked. In lieu thereof, reference designation markings shall be shown by means of a pictorial diagram, line drawings, photographs, or other media to provide for circuit identification (by means of reference designations) appropriate for the equipment.

1-3.12.12 Nonelectrical parts.- The reference designation for each nonelectrical part, except screws, nuts, washers, bushings, pipe fittings, and similar small hardware, shall be marked on the chassis, frame, panel, etc., immediately adjacent to the part; but if space is not available, the reference designation shall be marked on the part itself.

1-3.12.13 Panel markings.- The visible surface adjacent to panel facilities such as connectors, controls, indicators, jacks, keys, switches, and fuse holders shall be marked with a suitable word, phrase,. or abbreviation, indicating the use or purpose of the part. These markings shall be legible so that the function of the panel facility can be identified by the operator. Continuously variable operating controls shall be provided with markings that permit the operator to set the control to a predetermined point. Markings on the fronts of panels and panel doors (other than equipment nameplates, 1-3.13) shall be made in accordance with one of the following subparagraphs.

1-3.12.13.1 Individual designation plates.- One of the following types shall be used (thicknesses shown are minimum acceptable values):

(a) 0.03-inch aluminum (overall water-dip lacquer on finished plate) or 0.03-inch nickel silver; reverse-etched, raised characters with dull metal finish; depressed background finished in black enamel.

(b) 0.02-inch photosensitive anodized aluminum processed for white metal characters with jet black background; photosensitive silver compounds shall be imbedded within the oxide layer; and image shall be sealed in the oxide layer by chemical treatment.

(c) 0.04-inch aluminum, baked finish or anodized finish, dull black, engraved through the finish.

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(a) 0.03-inch aluminum (overall water-dip lacquer on finished plate) or 0.03-inch nickel silver; reverse-etched, raised characters with dull metal finish; depressed background finished in black enamel.

(b) 0.02-inch photosensitive anodized aluminum processed for white metal characters with jet black background; photosensitive silver compounds shall be imbedded within the oxide layer; and image shall be sealed in the oxide layer by chemical treatment.

(c) 0.04-inch aluminum, baked finish or anodized finish, dull black, engraved through the finish.

1-3.12.15.2 Location of stamping.- The stamping shall be located on the back of the front panel door, unless the required space is not available, in which case the stamping shall be located on the rear vertical surface of the chassis. If space is not available in either location or where construction differs from that described above, the contractor shall obtain Government approval of the proposed location before stamping the equipment.

1-3.13 Nameplates.

1-3.13.1 Nameplates required.- Each equipment furnished shall have one or more nameplates as determined by the equipment configuration. Each nameplate shall be in accordance with FAA-G-2100, paragraph 3.10.

1-3.13.2 Contractor's nameplate drawing.- Before manufacturing the nameplate, the contractor shall submit his detailed manufacturing drawing of the nameplate to the Federal Aviation Administration, Washington, D.C. 20590, Attention: Contracting Officer, for checking of entries and other requirements. The drawing shall be in complete detail showing all entries, except that the equipment type designation, if not known to the contractor, may be omitted. In such case, the type designation will be assigned when the checked drawing is returned to the contractor.

1-3.13.3 Serial numbers.- Serial numbers shall start with "1" for each equipment unit having an individual nameplate and continue consecutively up to the total number of such equipment units on the contract.

1-4. QUALITY ASSURANCE PROVISIONS

1-4.1 Quality control provisions.- The contractor shall establish and maintain a quality control program in total compliance with FAA-STD-013.

1-4.1.1 Government inspections.- All tests and inspections made by the contractor shall be subject to Government inspection. The term "Government inspection," as used in this specification, means that an FAA representative will witness the contractor's testing and inspection, and will carry out such visual and other inspections as deemed necessary to assure compliance with contract requirements. Tests shall be conducted at the contractor's plant or test facility and at the contractor's expense. All test facilities, instrumentation, connection, and personnel necessary to conduct the tests required by this specification shall be furnished by the contractor.

1-4.1.2 Copies of test documentation.- For all tests required by applicable specifications, four copies of the proposed list of tests, test procedures, and blank test data forms shall-be furnished to the Government as follows:

Three copies to the Contracting Officer or his designated technical representative and one copy to the resident FAA Quality and Reliability Officer if assigned, otherwise forwarded to the Federal Aviation Administration Contracting Officer or his designated technical representative,

Copies shall be furnished in advance of the contractor's scheduled date for testing to allow the Government time for review and evaluation. One copy will be returned to the contractor, either with a statement that the proposed methods and forms are approved by the Government for use or with a statement pointing out deficiencies to the proposed methods and forms. In the event of the latter, the contractor shall resubmit his revised methods and forms. The approved forms shall be used for preparation of the test data sheets for the testing of all products on the contract.

1-4.1.3 Government right to waive inspection.- The Government reserves the right to waive Government inspection. If Government inspection is waived, the contractor shall nevertheless perform all of the required tests utilizing the Government-approved test procedures and furnish certified test data recorded on the approved forms. The test data must substantiate that the product meets contract requirements and shall include the statement, "This certifies that this product fully meets all technical requirements of the contractor." It shall be dated and signed by a responsible contractor official. Copies of certified test data shall be furnished as specified in FAA-STD-013. Shipment shall not be made until the contractor receives written Government approval of the data.

1-4.2 Contractor's detailed test plan.- The contractor shall develop the test procedures he proposes to conduct as a means of proving compliance with the requirements of this specification. These tests shall identify all detailed procedures to be performed and shall be submitted to the Government for formal review and approval. All test procedures shall reference the specific specification paragraph number being demonstrated. The tests proposed by the contractor shall include the tests of 1-4.4. The plan shall include, but is not limited to, the following information in the following sequence, for each test:

(a) Sequence and schedule of tests.

(b) Description of how the test is to be performed, including operating modes.

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(a) Sequence and schedule of tests.

(b) Description of how the test is to be performed, including operating modes.

1-4.2.1.4 Inspection after each test.- At the completion of each test, the equipment shall be examined for indications of damage or deterioration to assure specification compliance.

1-4.3 Validation and demonstration of quality requirements.- The procedure to be followed by the contractor in validating and demonstrating that the RVR system meets the requirements of this specification consists of four phases:

Phase I - Prebid sensor validation.
Phase II - Reliability verification.

Phase III - Preproduction testing.

Phase IV - Production testing.

1-4.3.1 Phase I. Prefabrication sensor validation.- The sensors included in the RVR system submitted in formal response to this offering shall have been sufficiently tested to demonstrate their ability to meet the performance set forth in this specification. Other factors, such as reliability, can be presented based on other than empirical documentation. As a minimum, these tests shall be the same as (or be equivalent to) the tests outlined in this specification for each sensor and shall have been accomplished by the contractor or the sensor vendor. These tests shall be fully documented and shall provide justification that the sensor meets the accuracy and reliability requirements of this specification within the stated environmental conditions.

1-4.3.2 Phase II. Reliability verification.- After contract award, the contractor shall verify, through a series of verification reviews, that his overall system is in compliance with the reliability requirements of this specification. Mathematical modeling shall be used to predict system reliability.

1-4.3.2.1 Reliability modeling.- A reliability model (MIL-STD-785B, Task 201) based on system/subsystem functions shall be developed and maintained. As the design evolves, a reliability block diagram shall be developed and maintained for the system/subsystem with associated allocations and predictions for all items in each reliability block. The reliability block diagram shall be keyed and traceable to the functional block diagram, schematics, and drawings and shall provide the basis for accurate mathematical representation of the RVR system reliability. Nomenclature of items used in reliability block diagrams shall be consistent with that used in functional block diagrams, drawings, schematics, and specifications. The model outputs shall be expressed in terms of contractual reliability requirements and other reliability terms as specified. The reliability model shall be updated with information resulting from reliability and other relevant tests,

as well as changes in configuration and operational constraints. Inputs and outputs of the reliability mathematical model shall be compatible with the input and output requirements of the system and subsystem level analysis models.

1-4.3.2.2 Reliability prediction.- Reliability predictions (MIL-STD-785B, Task 203) shall be made for the system/subsystem. System reliability shall be based upon failure rates of critical subsystems, as defined in paragraph 1-3.7.2. Predictions shall account for, and differentiate between, each mode of operation as defined in this specification. Predictions shall be made showing basic reliability (MTBF) of the item during the life specified by the Government to provide a basis for life-cycle cost and logistics support analysis. These predictions shall be made using the associated reliability block diagram and failure rate data approved by the Government. Items shall not be excluded from the reliability predictions unless substantiating documentation verifies that the item failure has no influence on the required measure of reliability. Prior to such exclusions from the predictions, an assessment and approval shall be obtained from the Government. The following guidelines shall be used in the reliability predictions:

(a) When the individual part operating conditions are defined, the prediction procedure in section 2 of MIL-HDBK-217 shall be used.

(b) If part type and quantity is the only information available, the prediction procedure of section 3 of MIL-HDBK-217 shall be used.

(c) Predictions for electronic equipment shall be made using one of the two methods contained in MIL-HDBK-217. Predictions for mechanical, electrical, and electro-mechanical equipment shall be made using either contractor data or alternatives, both of which shall require Government approval.

(d) The use of failure rate data obtained from past experience of system components may be applicable for the RVR system depending upon the degree of similarity existing both in the hardware design and in the anticipated environments. Use of such data is subject to approval of the Government.

1-4.3.2.3 Reliability verification reviews.- The contract shall specify at least two reliability verification reviews: a preliminary review and a final review. These reviews will give the contractor the opportunity to provide the results of his reliability prediction to the Government. During the final review, reliability predictions based upon the reliability model shall reflect compliance with the reliability requirements of this specification (1-3.7.2). Upon acceptance,

as well as changes in configuration and operational constraints. Inputs and outputs of the reliability mathematical model shall be compatible with the input and output requirements of the system and subsystem level analysis models.

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mental testing. These tests are part of the Test, Analyze, and Fix (TAF) concept MIL-STD-2068(AS). Therefore, any failure or excessive repair or recalibration shall be the subject of analysis; and corrective action shall be defined. Any design change or modification that results shall be immediately implemented on one or both (at the discretion of the Government) of the system(s) in this test program to demonstrate the adequacy of the fix. When all appropriate tests have been successfully demonstrated, the change shall be implemented on all RVR systems.

1-4.3.3.3 Design changes or system modifications.- During the tests outlined above, any problems, failures, or other reasons for noncompliance with the provisions of this specification shall be the subject of immediate analysis. When this analysis determines the need for a design change, modification, or other "fix," the contractor shall be responsible for the retrofit of all systems produced, as well as incorporation of the change on all new production equipment.

1-4.3.3.4 Production approval.- The Government shall not approve full production of the RVR system until the tests outlined in this paragraph have satisfactorily demonstrated compliance with the functional, accuracy, reliability, maintainability, and other requirements of this specification.

1-4.3.4 Phase IV. Production testing.- During production, production (1-4.4.4) and type (1-4.4.5) tests shall be performed in accordance with this specification.

1-4.4 System testing.- Five classes of tests are required to complete the four phases in the validation and demonstration of quality requirements as follows:

(a) Contractor's preliminary tests (1-4.4.1)

(b) Design qualification (first article acceptance) tests (1-4.4.2)

(c) Reliability and maintainability tests (1-4.4.3)

(d) Production tests (1-4.4.4)

(e) Type tests (1-4.4.5)

1-4.4.1 Contractor's preliminary tests.- Prior to the time the contractor notifies the Government that the initial production equipment is ready for inspection and to demonstrate readiness for inspection, he shall make one complete set of all preliminary tests required by this specification. These preliminary tests shall be made on the subsystem components of two prototype systems. The contractor's preliminary tests do not constitute any of the regular design

mental testing. These tests are part of the Test, Analyze, and Fix (TAF) concept MIL-STD-2068(AS). Therefore, any failure or excessive repair or recalibration shall be the subject of analysis; and corrective action shall be defined. Any design change or modification that results shall be immediately implemented on one or both (at the discretion of the Government) of the system(s) in this test program to demonstrate the adequacy of the fix. When all appropriate tests have been successfully demonstrated, the change shall be implemented on all RVR systems.

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(e) Type tests (1-4.4.5)

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(a) Production tests. (Paragraph 1-4.4.2.1)

(b) Environmental tests. (Paragraph 1-4.4.2.2)

(c) Power and electromagnetic tests. (Paragraph 1-4.4.2.3)

(d) Functional and accuracy tests. (Paragraph 1-4.4.2.4)

(e) Reliability tests. (Paragraph 1-4.4.3)

(f) Maintainability demonstration. (Paragraph 1-4.4.3)

1-4.4.2.1 Production tests.- Each RVR system to be used in the design qualification tests shall first pass the production tests (1-4.4.4). In addition, each system shall be first visually inspected for:

(a) Accessibility of components for maintenance (1-3.3.1.3, 1-3.3.2).

(b) Any unsafe features (1-3.3.3.9).

(c) Cable connectors, circuit boards, modules, sensors, etc., for specification design compliance (1-3.3.3).

(d) Adequacy of maintenance test points (1-3.3.3.12).

1-4.4.2.2 Environmental testing.- The contractor shall develop the necessary tests (subject to Government approval) to assure that the RVR system complies with the performance requirements of this specification under the environmental conditions specified in 1-3.2.3.2 and parts 2 through 10. Some of these tests may be performed concurrently with other design qualifications tests. These tests shall be conducted in accordance with the test plan (1-4.2). This plan shall define the environmental test levels for each test (which may be different for various RVR subsystems), the RVR system state during each phase (operating or nonoperating), and RVR system inputs and expected outputs. Standard and special instrumentation shall be defined. The test plan shall define the failure criteria for the test. They shall include:

(a) Inability of any item to perform its required function within the specified limits under stated conditions. Examples of this type of failure include drift, intermittant operation, lack of response to Inputs, output loss, etc.

(b) Catastrophic failures due to a mechanical or structural failure resulting from any of the environmental tests.

1-4.4.2.3 Power, electromagnetic, and lightning protection testing.- The RVR system shall be subjected to power, electromagnetic, and lightning protection testing using a contractor-developed, Government-approved procedure that incorporates the following guidelines:

(a) Power input variation tests - The RVR system shall be subjected to maximum and minimum frequencies and voltages specified (102 and 138 volts, 59 and 63 Hz). No degradation of RVR system accuracy or performance shall occur as a result of under or overvoltage, low or high frequency, or combination thereof. The RVR system shall be evaluated for degradation of accuracy or performance for a minimum of 15 minutes at each extreme of voltage and frequency.

(b) Momentary undervoltage tests - The RVR system shall be subjected to momentary undervoltage tests (i.e., below 102 V) and shall suffer no permanent damage to accuracy or performance when returned to normal operation voltages.

(c) Abnormal surge voltage - The RVR system shall be subjected to an abnormal surge voltage of 148 V rms, 60 Hz for 1 second without generating erroneous outputs or suffering permanent damage to the RVR components. Upon application of normal rated voltage (120 V AC, 60 Hz), the RVR components shall be checked for accuracy and performance. As a minimum, the surge voltage shall be applied to the RVR system three times at lo-second intervals.

(d) Transient susceptibility tests - The RVR system shall be tested for degradation of accuracy or performance due to powerline transients and signal line transients.

(1) AC powerline transient susceptibility shall be evaluated in accordance with NWS Transient Susceptibility Standard, May 1978, Test Level I, with a no-upset acceptance criteria.

(2) Signal line transient susceptibility shall be evaluated in accordance with NWS Transient Susceptibility Standard, May 1978: crosstalk with a no-upset acceptance criteria and lightning tests with a no-reset acceptance criteria.

(b) Catastrophic failures due to a mechanical or structural failure resulting from any of the environmental tests.

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matrix thus consists of three obstructions to vision by two extinction coefficient ranges. Each box in the matrix should have at least 100 samples (except as noted above). All data collected must be included, but the number of data samples falling outside the 16.5% error levels (see Appendix I) must be normalized to the total number of samples under given conditions. In order to meet the accuracy test, no more than 10 percent of the data samples weighted over the entire test matrix may fall outside the 16.5-percent error limit. Also, less than one percent shall show errors larger than a factor of two.

Test Matrix Weighting (Percent)

Extinction Coefficient (km^{-1})	Fog	Rain	Snow
15-50	20	6.7	6.7
50-350	20	6.7	6.7

1-4.4.2.4.3 System stability tests.- Tests shall be performed to demonstrate that the RVR system complies with the system stability.

1-4.4.3 Reliability and maintainability testing

1-4.4.3.1 Reliability development testing.- The contractor shall conduct reliability development testing to determine that the RVR system is in compliance with the requirements of 1-3.7, as described in the Reliability Program Plan (1-3.7.3.1), and 1-4.3.3.2.

Four systems shall be tested. Two shall be the systems subjected to the test procedures previously described in 1-4.4.2 (Design Qualification Tests). After satisfactory completion of these tests, these units shall be installed by the contractor in an operational location (to be determined by the Government). System performance will be continuously monitored and documented by the contractor for an operational test life of 6 months. (After 6 months of operation, these systems will undergo repeat testing of the design qualification test procedures (1-4.3.3.1).

The remaining two systems subjected to reliability development testing shall be installed by the contractor at locations approved by the Government. The sites will be selected to subject the equipment to naturally occurring environmental extremes, as well as other conditions not readily stimulated in an environmental laboratory, such as bugs, birds, unstable soil, etc.

In addition to providing reliability data, the tests shall also serve other purposes. They will demonstrate proper RVR system operation (correct measurement and processing of data and products, operator and user interfaces, operation of the product dissemination devices, and

circuits) and the adequacy of the preventative maintenance procedures and intervals.

The reliability tests shall be designed to establish sensor stability, general system serviceability (i.e., no problems with insects, birds, or other unforseen environmental factors), and to provide an estimate of system and subsystem MTBF. The RVR systems under test shall receive the preventative (scheduled) maintenance specified in the maintenance manual (1-3.5). System operation shall be monitored daily, and any failures or out-of-specification performances shall be immediately documented and corrected. Data to be collected shall include, but is not limited to:

(a) Calibration/maintenance log.

(b) Notes of any unusual effects upon performance (i.e., fog on lens/window, spider webs, etc.).

(c) Failure description and restoration actions accomplished.

(d) Time to correct each failure.

1-4.4.3.2 Maintainability demonstration.- A maintainability demonstration shall be conducted on one system to verify that the objectives of the maintainability program (1-3.7.4) have been met. Faults shall be randomly inserted into each component of the system and corrective maintenance times recorded. The individual(s) performing the maintenance will be an FAA electronics technician who has received indoctrination training in accordance with the contractor-developed operations and maintenance manual (1-3.5). Corrective repair times for each maintenance task shall consist of:

(a) Time to sense or verify a failure.

(b) Time to locate the fault.

(c) Time to isolate to a removable or adjustable component, module.

(d) Time to remove/replace.

(e) Time to make adjustments.

(f) Time to verify correct operation.

The total time to complete each task shall be measured, and the arithmetical mean of the times shall be calculated. The MTTR shall not exceed 30 minutes, and 90 percent of the repair times shall be less than 1 hour.

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The total time to complete each task shall be measured, and the arithmetical mean of the times shall be calculated. The MTTR shall not exceed 30 minutes, and 90 percent of the repair times shall be less than 1 hour.

(c) Component fit.

(d) Finishes.

(e) Welds.

(f) Solder joints.

(g) Lubrication.

(h) Corrosion prevention.

(i) Grounding.

(j) Conformity to standard parts.

(k) Other visible defects.

1-4.4.4.2.2 Electrical performance tests.- Each RVR system shall be given a thorough electrical performance test to determine that all circuits are inherently sound and that overall performance of the equipment is in compliance with the requirements of this specification. The tests shall include, but are not necessarily limited to: proper functioning of all lamps, switches, displays, controls, circuit breakers; proper voltages at all test points; proper built-in test capability.

1-4.4.4.2.3 Burn-in test.- Each RVR system shall be subjected to a 48-hour burn-in test (with temperature cycling of at least three times from specified minimum to maximum temperature) for verification of the manufacturing production process. In case of failure, the test shall be restarted after repair and shall be run until 48 continuous failure-free hours are accumulated. All failures shall be documented and analyzed, and appropriate corrective action shall be taken if failure trends are indicated.

1-4.4.4.2.4 Mechanical performance tests.- Each RVR system shall be given a thorough mechanical test to insure compliance with the mechanical requirements of this specification. This test shall include, but not be limited to, trials to demonstrate the function and completeness of operating parts, blowers, connectors, and controls. In addition, prior to the burn-in test (1-4.4.2.3), the equipment shall be subjected to random vibration of 5g rms in a direction perpendicular to the plane of the printed circuit boards (equipment is not operating).

1-4.4.4.2.5 System calibration test.- The contractor shall include a procedure within his test plan that will result in factory calibration of the system within the accuracy requirements of 1-3.2.1.3. This

(c) Component fit.

(d) Finishes.

(e) Welds.

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1-4.4.4.2.5 System calibration test.- The contractor shall include a procedure within his test plan that will result in factory calibration of the system within the accuracy requirements of 1-3.2.1.3. This

(b) When the type test is successfully completed, the system in the group from which the type test system was taken is released for final inspection and shipment; the equipments in the next succeeding type test group are released for inspection and production testing only. If it is the last type test group, successful completion Of the type test releases all remaining systems for final inspection and shipment.

(c) If a type test is not sucessfully completed and requires parts or design changes, or both, in order to meet the specified type test parameters:

(1) These parts or design changes, or both, shall be incorporated in the group from which the type test system was taken; and all systems shall be retested to the extent determined necessary by the Government:, prior to final inspection, acceptance, or delivery,

(2) The contractor shall propose a plan, acceptable to the Government, for the correction/modification of previously accepted and delivered systems in accordance with the contract. Where field modification is appropriate (whether by contractor or Government personnel), the contractor shall provide the necessary parts, instructions, and instruction manual revisions in accordance with FAA Order 1320.33B, "Equipment Modification and Facility Instruction Directives."

1-4.5 Test equipment.

1-4.5.1 Furnishing of test equipment.- The contractor shall supply all test equipment necessary for the tests required. The contractor shall provide and maintain all measuring and test equipment in accordance with FAA-STD-013 or the contract schedule, including on-site testing if installation is a requirement of the contract.

1-4.5.2 Basic instrument accuracy.- Instruments for measurement of certain basic electrical quantities shall have the accuracies specified in Table 1-III, or better (instrument manufacturer's rating or testing laboratory certification). The percentages given in Table 1-III for indicating instruments are percentages of full scale. All readings shall be made within the upper 50 percent of the scale arc.

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(1) These parts or design changes, or both, shall be incorporated in the group from which the type test system was taken; and all systems shall be retested to the extent determined necessary by the Government:, prior to final inspection, acceptance, or delivery,

(2) The contractor shall propose a plan, acceptable to the Government, for the correction/modification of previously accepted and delivered systems in accordance with the contract. Where field modification is appropriate (whether by contractor or Government personnel), the contractor shall provide the necessary parts, instructions, and instruction manual revisions in accordance with FAA Order 1320.33B, "Equipment Modification and Facility Instruction Directives."

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1-4.5.5 Humidity measurement accuracy.- The techniques used to measure relative humidity shall provide readings within 5 percentage points of true relative humidity.

1-4.5.6 Instrument accuracy for other measurements.- Instruments for the measurement of quantities other than those specified in 1-4.5.2 to 1-4.5.5 shall have actual calibrated accuracies greater by a factor of three (as a minimum) with reference to the tolerance specified for each electrical quantity.

1-4.6 Availability of applicable documents.- The contractor shall make available for reference use by the FAA QRO a complete set of the applicable documents (specifications, publications, -drawings, etc., except those issued by the FAA) for the equipment being furnished on the contract.

1-4.7 Inspection of design and production status.- Upon request from the Government, the contractor shall make available for review at his plant, at any stage of the contract, all information regarding the design and production status of the equipment being manufactured under the contract. Such information shall be available at the plant regardless of- point of manufacture of the individual components. The contractor shall provide, for retention by the Government, two copies of each schematic and logic diagram on all electronic assemblies. The schematics shall be those in effect at the time the request is made; and all subsequent revisions shall be provided, if requested by the Government.

1-5. PREPARATION FOR DELIVERY

1-5.1 General preparation requirements.- The RVR subsystems, with the exception of sensors, shall not require disassembly prior to packaging. Preservation, packaging, and marking shall be in accordance with the requirements of MIL-E-17555G.

1-5.2 Preservation and packaging.- Each unit, complete with two sets of instruction books, shall be individually preserved and packaged in accordance with MIL-E-17555G, subparagraph 3.3.1, Level C.

2-3.2.1.2 Sensor resolution.-

100 feet from	100 to 800 feet
200 feet from	800 to 3,000 feet
500 feet from	3,000 to 6,000 feet

Paragraph 1-3.2.1.3 lists the reporting values and breakpoints for various light settings and backgrounds.

2-3.2.1.3 Accuracy.- The visibility sensor shall have an accuracy of: ± 10 percent (root-mean-square equivalent) of an RVR value. (Note that Paragraph 1-3.2.1.4 requires a system accuracy of less than ± 10 percent of the RVR value (RMSE)).

By "root-mean-square equivalent" is meant the equivalent 90-percent confidence level of a normal error distribution having a standard deviation of 10 percent. The 90 percent confidence level corresponds to 1.65 times the standard deviation or a 16.5 percent error. Thus the calculated RVR value must agree with a standard measurement to within 16.5 percent accuracy at least 90 percent of the time. It must also agree to within a factor of two 99 percent of the time. A fractional error in extinction coefficient translates into a fractional error in RVR that is equal to or somewhat smaller. In order to meet the RVR accuracy requirement, the sensor will be required to meet the more stringent requirement of applying the 90-percent and 99-percent confidence levels to extinction coefficient errors rather than RVR errors.

2-3.2.2 Background sensitivity.- Measurements from the visibility sensor shall not be affected by sunlight nor by rapid changes (i.e., one minute) in background light.

2-3.2.3 Calibration.- A method of calibration traceable to an FAA transmissometer standard must be provided. Instruments which are not transmissometers must be supplied with a calibration by which their response can be checked. For all sensors, these calibrations must be included: zero signal, mid-range signal and near maximum. The purpose of the mid-range calibration is to check the linearity of the sensor.

2-3.2.3.1 Sensor stability.- The sensor stability in a 90-day interval shall not cause an RVR error of more than I 0 percent for the most sensitive reporting value.

2-3.2.4 Scattered Light Error in Transmissometers.- A very important consideration in the accuracy of a transmissometer measurement is the extent to which it measures the regular transmittance of the atmosphere and is not influenced by scattered light, that would not ordinarily be received in the absence of the scattering medium, and which constitutes an error in the measurement.

2-3.2.4.1 Absorption Error in Scattering Coefficient Meters.- A very important consideration in the accuracy of RVR values derived from scattering coefficient meters is the extent to which the instrument

2-3.2.1.2 Sensor resolution.-

100 feet from	100 to 800 feet
200 feet from	800 to 3,000 feet
500 feet from	3,000 to 6,000 feet

Paragraph 1-3.2.1.3 lists the reporting values and breakpoints for various light settings and backgrounds.

2-3.2.1.3 Accuracy.- The visibility sensor shall have an accuracy of: ± 10 percent (root-mean-square equivalent) of an RVR value. (Note that Paragraph 1-3.2.1.4 requires a system accuracy of less than ± 10 percent of the RVR value (RMSE)).

By "root-mean-square equivalent" is meant the equivalent 90-percent confidence level of a normal error distribution having a standard deviation of 10 percent. The 90 percent confidence level corresponds to 1.65 times the standard deviation or a 16.5 percent error. Thus the calculated RVR value must agree with a standard measurement to within 16.5 percent accuracy at least 90 percent of the time. It must also agree to within a factor of two 99 percent of the time. A fractional error in extinction coefficient translates into a fractional error in RVR that is equal to or somewhat smaller. In order to meet the RVR accuracy requirement, the sensor will be required to meet the more stringent requirement of applying the 90-percent and 99-percent confidence levels to extinction coefficient errors rather than RVR errors.

2-3.2.2 Background sensitivity.- Measurements from the visibility sensor shall not be affected by sunlight nor by rapid changes (i.e., one minute) in background light.

2-3.2.3 Calibration.- A method of calibration traceable to an FAA transmissometer standard must be provided. Instruments which are not transmissometers must be supplied with a calibration by which their response can be checked. For all sensors, these calibrations must be included: zero signal, mid-range signal and near maximum. The purpose of the mid-range calibration is to check the linearity of the sensor.

2-3.2.3.1 Sensor stability.- The sensor stability in a 90-day interval shall not cause an RVR error of more than I 0 percent for the most sensitive reporting value.

2-3.2.4 Scattered Light Error in Transmissometers.- A very important consideration in the accuracy of a transmissometer measurement is the extent to which it measures the regular transmittance of the atmosphere and is not influenced by scattered light, that would not ordinarily be received in the absence of the scattering medium, and which constitutes an error in the measurement.

2-3.2.4.1 Absorption Error in Scattering Coefficient Meters.- A very important consideration in the accuracy of RVR values derived from scattering coefficient meters is the extent to which the instrument

- Range
- Accuracy
- Background sensitivity
- Calibration stability
- Scattered light error, etc.

(c) Sensor monitoring test

These tests shall be performed in addition to those given in part 1-4 of this specification.

2-4.2.1 Environmental stress screening (ESS).- The purpose of these tests is for the early identification of failures of parts, subassemblies, and complete units due to weak parts, workmanship defects, and other nonconformance anomalies. During ESS, the sensor shall be cycled through its operational modes in accordance with the test procedures of FAA-G-2100, paragraph 4-11, while simultaneously being subjected to the environmental service conditions of 2-4.2.2.

2-4.2.2 Environmental service conditions.- Each RVR sensor furnished by the contractor shall be installed at airports for continuous and unattended operation outdoors. The components shall withstand and operate without damage or degradation of performance during shipment, storage, and operationin accordance with the requirements of this specification when subjected to all combinations of environmental, mechanical, and electrical service conditions within the limitations of the following:

2-4.2.2.1 Natural environment.- The natural environmental service conditions are those designated as environment III in accordance with FAA-G-2100c, paragraph 3.2.15.

2-4.2.2.1.1 Rain.- Exposure to rain in accordance with MIL-STD-810c, Method 506.1.

2-4.2.2.1.2 Salt fog.- Exposure to salt fog in accordance with MIL-STD-810c, Method 509.1.

2-4.2.2.1.3 Dust.- Exposure to dust in accordance with MIL-STD-810c, Method 510.1.

2-4.2.2.1.4 Fungus.- Exposure to fungus in accordance with MIL-STD-810c, Method 508.1.

2-4.2.2.2 Induced Environment.- The induced environmental service conditions are those as specified herein.

2-4.2.2.2.1 Electromagnetic interference.- Exposure to electromagnetic emissions (see paragraph 1-3.3.3.6).

2-4.2.2.2.2 Acoustical interference.- Exposure to acoustic noise in accordance with MIL-STD-810c, Method 515.2.

2-4.2.2.2.3 Visible light interference.- Exposure to solar radiation (sunshine) in accordance with MIL-STD-810c, Method 505.1.

2-4.2.2.3 Mechanical.- The equipment shall withstand vibration and shock in accordance with MIL-STD-810c, Method 514.2 and Method 516.2.

2-4.2.2.4 Electrical.- The equipment shall operate when powered from a single-phase two-wire source, with the voltage and frequency characteristics below.

2-4.2.2.4.1 Voltage.- The equipment shall operate when powered from all voltages within the limits of 102 to 138 volts.

2-4.2.2.4.2 Frequency.- The equipment shall operate when powered from all frequencies within the limits of 57 hertz to 63 hertz.

2-4.2.3 Performance tests.- The contractor shall develop the test plan and procedures to demonstrate that the RVR sensor operates in accordance with the requirements of 2-3.2.1 and its subdivisions.

2-4.2.4 Sensor monitoring test.- Tests shall be performed to demonstrate that the sensor operates in accordance with the requirements of subparagraph 2-3.2.6.

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2-4.2.4 Sensor monitoring test.- Tests shall be performed to demonstrate that the sensor operates in accordance with the requirements of subparagraph 2-3.2.6.

PART 3 - DATA PROCESSING UNIT

3-1. SCOPE

3-1.1 Purpose.- This part establishes the performance, design, and test requirements for the data processing unit (DPU) of the RVR system. The general requirements for the RVR system contained in part 1 form a part of this specification.

3-2. APPLICABLE DOCUMENTS

3-2.1 General.- The applicable documents for part 3 are contained in part 1, 1-2.

3-3. REQUIREMENTS

3-3.1 General.- The main functions of the DPU are data acceptance, data processing, and product dissemination to the CPU. The DPU accepts data inputs, performs various data processing functions, implements the RVR algorithm, and prepares DPU products for dissemination. The DPU shall be a plug-in module of the CPU. The DPU software shall include the algorithms for data reduction, a DPU monitor program, diagnostics, and appropriate routines for execution of the various DPU functions.

3-3.1.1 Equipment to be furnished by the contractor.- The contractor shall provide the plug-in module DPU to accept, process, and distribute RVR values and additional information as specified herein.

3-3.2 DPU characteristics.

3-3.2.1 DPU inputs

3-3.2.1.1 Visibility sensor.- The DPU shall accept a serial ASCII signal from the remote data collection interface (RDCI) unit for the visibility sensor. The DPU shall process the input from only one visibility sensor.

3-3.2.1.2 Ambient light sensor.- The DPU shall accept a serial ASCII signal from the remote data collection interface (RDCI) unit for the ambient light sensor.

3-3.2.1.3 Runway light intensity monitor.- The DPU shall accept a serial ASCII signal from the remote data collection interface (RDCI) unit for the runway light intensity monitor.

3-3.2.1.4 Central processing unit.- The DPU shall accept a signal from the central processing unit.

3-3.2.1.5 External interface requirements.- Data transmission between the RDCI, ALS, RLIM, and DPU shall be bit oriented and asynchronous

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3-2.1 General.- The applicable documents for part 3 are contained in part 1, 1-2.

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3-3.2.1.5 External interface requirements.- Data transmission between the RDCI, ALS, RLIM, and DPU shall be bit oriented and asynchronous

the DPU. The measurement shall always be performed when power is initially applied to the DPU. The measurement shall be performed on each transition of the ambient illumination level. Provision shall be made to visually indicate at the central maintenance display/recorder and each remote display that the measurement is in progress. The measurement shall take 1 minute or less. This applies only to those sensors that are sensitive to background changes.

3-3.2.2.3 DPU output.- The DPU shall provide an output to the central processing unit (CPU).

3-3.2.3 DPU products.- The DPU shall generate the following information.

(a) Appropriate runway (e.g., RWY 32L)

(b) RVR location (e.g., touchdown, midpoint, rollout)

(c) RVR value (e.g., 1800)

(d) Raw visibility sensor data

(e) Ambient light (e.g., bright day, day, twilight, night)

(f) Runway light intensity (e.g., step 0-2, 3, 4, or 5)

(g) Remote maintenance monitoring status as follows:

(1) Visibility sensor lamp operating time

(2) Visibility calibration verification

(3) Cable/sensor failure

3-3.2.4 Product dissemination.- The DPU shall output its various products via the interface ports described in 3-3.2.5.1.

3-3.2.4.1 Automatic dissemination.- The DPU output shall be routed automatically to those output ports that feed equipment with a receive-only capability and by command to the CPU.

3-3.2.5 Hardware.- In order to accomplish the above functions, the DPU shall satisfy the following hardware requirements:

3-3.2.5.1 Interface ports.- Interface ports shall be asynchronous serial EIA-RS-449/232C* compatible balanced interface ports. The product format shall be the same ASCII format for all output ports. Where differing display formats are required, the display shall be programmed to reformat the data.

(a) Data input

1 input from CPU

3 inputs from RDCI (serial ASCII)
2 spares (serial ASCII)

(b) Data output

1 output for operations display units (one CMT/R, up to 6 tower cab, and as many as 20 TRACON displays)

1 output to CPU

1 spare (serial ASCII)

*As used in this specification, RS-449/232C compatible, means the contractor shall provide the capability to interface 232C and 449 devices with the local and off-site terminals in accordance with ELA-RS-232C and 449. This may be accomplished by having a 449 connector on the terminals with an external 449/232C adapter, or by having connectors for 232C and 449 on the terminals.

3-3.2.5.2 Memory.- For future growth, the DPU will contain 50 percent more memory than necessary to accomplish the requirements of this specification. The DPU shall contain three types of memory applications:

(a) The EPROM shall contain all DPU programs, default system parameters, algorithm constants, and the software version number.

(b) The RAM shall contain the variable sensor parameters; status; and configuration, archived data, and maintenance information. This memory shall be protected with a rechargable battery source capable of retaining the memory for a period of 2 hours.

(c) Current data input from the sensors and DPU calculations shall be stored in a RAM.

3-3.2.5.3 Processor(s).- Enough processing power in the DPU must be available to meet all specified functions with 50 percent excess in processing time. The processor shall have the capability to double the processing rate (for test purposes); therefore, all algorithm processing shall be accomplished when data input rates are doubled.

The following response times shall be achieved;

(a) RVR processing: time less than 3 seconds.

(b) The digital data response time shall be less than 5 seconds to begin the transmission. It shall include the time required to load a peripheral data buffer (in a display monitor, for example) with data from the DPU and for a formatted display to appear.

3 inputs from RDCI (serial ASCII)
2 spares (serial ASCII)

(b) Data output

1 output for operations display units (one CMT/R, up to 6 tower cab, and as many as 20 TRACON displays)

1 output to CPU

1 spare (serial ASCII)

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(1) Module name.

(2) Author name(s).

(3) Purpose - A brief statement identifying the purpose of the module.

(4) Execution method - The method of invoking the module.

(5) External references - All system modules and macros referenced within the module should be listed, together with the reason for the reference if necessary.

(6) Input arguments - Each argument listed by name. For each, its purpose, value restriction, type, and dimensions should be identified.

(7) Output arguments - Each output argument listed by name, with all information as per (6) (input) detailed.

(8) Externally addressed storage references - Each external block (word) referenced by the module shall be described by name, contents, and purpose of reference.

(9) Internal tables/work areas - A diagram or list showing the format of each table or work area shall be included. A reference to published or dictated tables may be sufficient.

(10) Method - A brief narrative describing the module execution may be specified. Where feasible, the module program design language (PDL) equivalent may be included in the prologue.

(11) Error processing - All error or exceptional conditions checked and the response to each condition shall be identified.

(12) Assumptions/restrictions - All inherent assumptions and restrictions regarding processing logic or data shall be clearly specified.

(13) Transportability limitations - All characteristics which limit the module's transportability shall be identified (e.g., processing steps which are dependent on specific sensors or data from particular devices).

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implementation. The earlier stages are subjected to considerable regression testing; thus, the amount of final testing is significantly reduced.

3-3.2.7.4 Program design language.- The PDL is a design and documentation tool that encourages a structured approach to program design. The PDL shall be used during all phases of module design and shall appear in the module prologue in the source listing. Sufficient and consistent comments and labels shall be embedded in the source code to correlate the PDL and the source code.

3-4. PERFORMANCE TESTS

3-4.1 DPU tests.- Tests of the DPU shall be performed in three stages.

(a) Digital data sets supplied by the contractor shall be input to the DPU and run at ambient temperature and at the environmental conditions specified in 1-3.2.3.2 to verify accurate and correct operation of the algorithms. Fixed and variable data sets shall be provided to exercise the DPU over the full range of possible sensor inputs and shall include various overrange and abruptly changing data to check the parameter quality control routines. Smaller data subsets shall be run with the DPU operating in extreme environmental conditions (Part 1, 1-3.2.3.2).

(b) Analog data sets (or digital data sets, if sensor output is digital) corresponding to the digital data above shall be input to RDCI and run at ambient and extreme environments to verify accurate and correct operation of the data acquisition subsystem when connected to the DPU.

(c) Finally, actual sensor devices shall be connected to the DPU through the RDCI interface and driven by actual or simulated weather conditions to verify accurate and correct operation of the entire RVR system. The sensors shall have passed their individual performance/acceptance tests.

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(b) Analog data sets (or digital data sets, if sensor output is digital) corresponding to the digital data above shall be input to RDCI and run at ambient and extreme environments to verify accurate and correct operation of the data acquisition subsystem when connected to the DPU.

(c) Finally, actual sensor devices shall be connected to the DPU through the RDCI interface and driven by actual or simulated weather conditions to verify accurate and correct operation of the entire RVR system. The sensors shall have passed their individual performance/acceptance tests.

4-3.2.2 Coded output.- The output of the ambient light sensor shall be a coded signal with a unique output corresponding to each level of ambient light.

4-3.2.3 Spectral response.- The overall spectral response shall approximate that of the human eye.

4-3.2.4 Obstruction.- The sensor shall be capable of preventing the obstruction of any part of the field of view due to ice, snow, or frost accumulation.

4-3.2.5 Environmental service conditions.- The ALS shall be designed for continuous, unattended operation in the environmental service condition as specified in 1-3.2.3.2.

4-3.2.6 Accuracy,- The accuracy of the ALS must be such as to insure the accuracy of the system in accordance with 1-3.2.1.4.

4-3.2.7 Remote maintenance monitoring.- The ALS shall include signal outputs to monitor the following parameters:

(a) Calibration verification.

(b) Cable/sensor fail alarm,

4-3.2.8 Calibration.- The calibration of the ALS shall be accomplished with the use of a calibrated photometer to measure the sky brightness. Certification of compliance and certification data for the calibrated photometer shall be provided by the contractor/manufacturer.

4-3.2.8.1 Stability.- The ALS shall remain stable within the specified system accuracy, 1-3.2.1.3, for a minimum of 90 days.

4-4. PERFORMANCE TESTS

4-4.1 ALS test.- The contractor shall develop the test plan and procedures to demonstrate that the ALS operates in accordance with the requirements of 4-3.2.6.

PART 5 - RUNWAY LIGHT INTENSITY MONITOR

5-1. SCOPE

5-1.1 Purpose.- This part establishes the performance, design, and test requirements for the runway light intensity monitor (RLIM) of the RVR system. The general requirements for the RVR system contained in part 1 form a part of this specification.

5-2. APPLICABLE DOCUMENTS

5-2.1 General.- The applicable documents for part 5 are contained in part 1, paragraph 1-2.

5-3. REQUIREMENTS

5-3.1 General.- The RLIM shall monitor the runway lighting system which includes both the centerline lighting system and the edge lighting system, select one of five brightness levels for each system, and provide a coded output signal to the DPU for each lighting system (centerline, edge).

5-3.1.1 Equipment to be furnished by the contractor.- The contractor shall provide the equipment, including power supplies, necessary to monitor the centerline lighting system and the edge lighting system,

5-3.2 Runway light intensity monitor characteristics.-

5-3.2.1 Stepless brightness control.- The RLIM shall be capable of sensing either voltage or switch position to gather data. Where a "stepless brightness" control is used to control the runway lighting system, the RLIM shall be able to distinguish and select one of the following ranges.

Edge Light Setting	Intensity (Typical)	Voltage (Typical)
5	10,000 Candelas	116 - 122
4	2,000 Candelas	89 - 100
3	400 Candelas	69 - 80
2*	0 Candelas	57 - 67
1*	0 Candelas	47 - 56

* These two settings shall be treated as if the runway lighting system is off.

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Edge Light Setting	Intensity (Typical)	Voltage (Typical)
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* These two settings shall be treated as if the runway lighting system is off.

PART 6 - REMOTE DISPLAY

6-1. SCOPE

6-1.1 Purpose.- This part establishes the unique performance and test requirements for remote displays. These displays can be used alone (receive-only functions) or in conjunction with the CMT/R (input-output) (part 7). The general requirements for the RVR system contained in part 1 form a part of this specification.

6-2. APPLICABLE DOCUMENTS

6-2.1 General.- The applicable documents for part 6 are contained in part 1, paragraph 1-2.

6-3. REQUIREMENTS

6-3.1 General.- The contractor shall provide the two basic types of displays depending upon ambient light conditions to be used under receive-only and input- output conditions. The displays shall be capable of receiving the incoming serial data stream, performing the required error checks, and formatting the data for display.

The contractor shall provide the following equipment as specified in the contract:

(a) Display for normal light conditions (75 to 100 ft candles) - For use by maintenance technicians and general users. Normal light conditions are defined as those locations having normal room light conditions without space restrictions.

(b) Display for high (up to 10,000 ft candles) or low (below 50 ft candles) ambient light conditions -

(1) Tower cab display - A display with a special anti-glare treatment of the front (viewing) surface, normally installed in an air traffic control tower.

(2) Terminal Radar Approach Control (TRACON) display - A display normally installed in a TRACON facility. The display shall be of limited size.

6-3.1.1 Equipment to be furnished by the contractor.- The contractor shall provide the equipment, including power supplies, necessary to display RVR values and selected information.

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6-3.1.1 Equipment to be furnished by the contractor.- The contractor shall provide the equipment, including power supplies, necessary to display RVR values and selected information.

Wave Length Range	Percent Reflectance	
	Angle = 0 to 15 degrees	Angle = 30 degrees
440 nm	.75 absolute	
450 nm	.5 absolute	
470 nm	.3 absolute	
500-600 nm	.4 absolute	
630 nm	.25 absolute	
680 nm	.5 absolute	
700 nm	.75 absolute	
450-650 nm		.8 absolute
425-700 nm		.5 absolute
500-620 nm		.5 average

b Antireflective coating durability - The coating shall be capable of withstanding each of the following conditions:

1 Continuous exposure for 24 hours in an atmosphere of 120° F and 90 percent ± 5 percent relative humidity without evidence of deterioration,

2 The "Scotch tape" test without evidence of deterioration. Apply a strip of l-inch wide tape, 3M #250, or equivalent, pressed down firmly by hand. With removal of the tape, there shall be no evidence of deterioration.

(b) Multiple data formats are required to present RVR information.

(c) To alert users' when an RVR value received from the DPU is below a threshold value preset by the user or a maintenance malfunction:

(1) It shall contain an audible alarm of variable intensity, to include an "on/mute" capability.

(2) It shall contain a visual alarm (blinking or reverse video, etc.) to highlight the information. Provisions shall be included to disable this feature by the operator.

(d) It shall be readable in light levels varying from normal room lighting to low ambient lighting at viewing angles up to 45° to the plane of the display and at a distance of 15 feet, by a person with normal (corrected to 20/20) vision.

Wave Length Range	Percent Reflectance	
	Angle = 0 to 15 degrees	Angle = 30 degrees
440 nm	.75 absolute	
450 nm	.5 absolute	
470 nm	.3 absolute	
500-600 nm	.4 absolute	
630 nm	.25 absolute	
680 nm	.5 absolute	
700 nm	.75 absolute	
450-650 nm		.8 absolute
425-700 nm		.5 absolute
500-620 nm		.5 average

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(1) It shall contain an audible alarm of variable intensity, to include an "on/mute" capability.

(2) It shall contain a visual alarm (blinking or reverse video, etc.) to highlight the information. Provisions shall be included to disable this feature by the operator.

(d) It shall be readable in light levels varying from normal room lighting to low ambient lighting at viewing angles up to 45° to the plane of the display and at a distance of 15 feet, by a person with normal (corrected to 20/20) vision.

6-3.2.2.1 Type of display.- The character size shall be approximately 3/8 inch wide and 1/2 inch high with 40 characters to the line and 12 lines displayed at any one time,

6-3.2.2.2 Panel size.- The panel containing the indicators, power on switch, and brightness control shall not exceed 6 inches high, 9 inches wide, and 6 inches deep. The panel shall be designed to be mounted through the front of a display console surface and secured.

6-3.2.2.3 Power supply.- The power supply for the display may be incorporated into the display or may be a separate unit attached by locking a connector to the display. If separate, AC power shall route from the mains to the display power switch and then to the power supply unit. It shall be DC overvoltage and overcurrent protected and shall be input fused. It shall be attached by a cable of approximately 6 feet to the display unit and shall properly provide regulated voltages and current as required. It will normally be installed in the TRACON consoles.

6-3.2.2.4 Controls.- The TRACON display (6-3.2.2) shall contain an on/off pushbutton switch which shall control AC power to the power supply. -Panel markings (e.g., control settings) shall be illuminated by a operator adjustable intensity control. An operator-adjustable brightness control shall be provided to vary the brightness of the indicators from 100 percent to 5 percent of brilliance. The display shall allow the operator to manually select 3 of 12 DPU outputs to be simultaneously displayed. For each RVR displayed, the display shall allow the operator to manually select an RVR alarm threshold.

6-3.2.2.5 Interface/addressing.- The TRACON display shall be addressable by up to 12 DPUs. The display shall contain interfacing electronics to permit data transfer between the DPU and the display unit. The display shall be capable of accepting data from the DPU at least once every 10 seconds. An RS-232C/RS-449 interface shall be provided.

6.3.2.3 Tower cab display.- The tower cab display shall be a display with an anti-glare treatment of the front (viewing) surface. The general requirements of this display are the same as those identified for the TRACON display, 6-3.2.2.

6-4. PERFORMANCE TESTS

6-4.1 Display test.- Tests of the displays shall be performed as follows:

(a) Digital data sets supplied by the contractor shall be input to the display and run at ambient, and the environmental conditions specified in 1-3.2.3.2 to verify accurate and correct operation of the algorithms. Fixed and variable data sets shall be provided to exercise the display over the full range of possible sensor inputs and shall include various overrange and abruptly changing data to check the parameter quality control routines. Smaller data subsets shall be run with the display operating in extreme environmental conditions (Part 1, 1-3.2.3.2).

6-3.2.2.1 Type of display.- The character size shall be approximately 3/8 inch wide and 1/2 inch high with 40 characters to the line and 12 lines displayed at any one time,

6-3.2.2.2 Panel size.- The panel containing the indicators, power on switch, and brightness control shall not exceed 6 inches high, 9 inches wide, and 6 inches deep. The panel shall be designed to be mounted through the front of a display console surface and secured.

6-3.2.2.3 Power supply.- The power supply for the display may be incorporated into the display or may be a separate unit attached by locking a connector to the display. If separate, AC power shall route from the mains to the display power switch and then to the power supply unit. It shall be DC overvoltage and overcurrent protected and shall be input fused. It shall be attached by a cable of approximately 6 feet to the display unit and shall properly provide regulated voltages and current as required. It will normally be installed in the TRACON consoles.

6-3.2.2.4 Controls.- The TRACON display (6-3.2.2) shall contain an on/off pushbutton switch which shall control AC power to the power supply. -Panel markings (e.g., control settings) shall be illuminated by a operator adjustable intensity control. An operator-adjustable brightness control shall be provided to vary the brightness of the indicators from 100 percent to 5 percent of brilliance. The display shall allow the operator to manually select 3 of 12 DPU outputs to be simultaneously displayed. For each RVR displayed, the display shall allow the operator to manually select an RVR alarm threshold.

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PART 7 - CENTRAL MAINTENANCE TERMINAL/RECORDER

7-1. SCOPE

7-1.1 Purpose.- This specification defines the performance, configuration, and test requirements for the central maintenance terminal/recorder (CMT/R) used by an on-site operator (an observer or maintenance technician) to monitor the output and status of the system, edit, and/or modify system outputs, reconfigure the system, enter or change site-dependent parameters, receive system failure messages, and perform failure diagnostics.

7-2. APPLICABLE DOCUMENTS

7-2.1 General.- The applicable documents for part 7 are contained in part 1, paragraph 1-2.

7-3. REQUIREMENTS

7-3.1 General.- The CMT/R shall be configured as a "smart" terminal. It shall include a display (specified in part 6), microprocessor, keyboard, magnetic storage capability, and any necessary RVR system processing interfaces. The CMT/R shall enable an on-site operator to perform the following functions:

(a) Monitor the output of the RVR system by displaying the CPU products on the CMT/R display.

(b) Permit manual entries of system parameters and comments in the Remarks Section of the CPU products. In the case of a sensor failure or an incorrect CPU output, the operator shall have the capability to replace the incorrect parameter value with a "missing" symbol in the RVR text.

(c) The CMT/R shall have the capability to locally set alarm (audio and video) thresholds for RVR values.

(d) The operator shall be able to use the CMT/R to reconfigure the RVR system keyboard entries, such as deleting or enabling a sensor, changing the site-dependent RVR constants.

(e) The operator shall be able to use the CMT/R to query the system in order to determine its status. The system shall be able to use the terminal for displaying all RMM parameters of any RVR subsystem or of the entire RVR system, depending on the requested data.

(f) The CMT/R shall perform the on-site RMM functions. A failure message shall be displayed and the failure message printed. The operator shall be able to use the CMT/R keyboard to perform system diagnostics down to the subsystem level to determine the cause of the failure message.

(g) The CMT/R shall store all data generated by the CPU on a storage medium. The CMT/R shall store a minimum of 15 days of data.

7-3.2 CMT/R performance characteristics,

7-3.2.1 RVR monitoring.- The CMT/R shall perform the system output monitoring function. At the request of an operator, the station shall display the current RVR output , maximum/minimum values measured by any RVR over a specific 10 minutes, the last hourly data, or the archived data.

When requesting archived data, it shall be possible to specify the time block in which data is requested, such as the last 12 or 24 hours or any time interval in the last 15 days. If the volume of data exceeds the capacity of the display's screen, it shall be paged or scrolled under operator control. The information shall be displayed in the same format required for the displays.

7-3.2.2 Manual data entry.- The CMT/R shall provide the capability for manually entering data into the system. The entry of data shall be facilitated by special keys on the CMT/R keyboard. The contractor shall propose to the FAA the procedures to implement the requirements of this section. FAA approval is required.

In order to insure against accidental activation of important keys such as the DELETE or ENTER keys, the entry procedure shall require two consecutive actions, such as after pressing the DELETE key, the system could prompt with "are you sure?" on the display requiring the operator to deliberately repeat his action.

7-3.2.3 Error detection.- The CPU processor shall check for incorrect entries by the operator, such as invalid runway designations, RVR identification, etc. Entry of incorrect data shall result in an error message on the display followed by text or a code indicating the reason for rejecting the data.

7-3.2.4 Security.- The CMT/R shall be designed to prevent unauthorized persons from entering data into the system. The system shall require the operator to enter a successive series of four codes in response to system queries prior to allowing him to proceed with the entry of data.

In the event more than one CMT/R is installed with one system, the operator shall designate the active CMT/R.

(f) The CMT/R shall perform the on-site RMM functions. A failure message shall be displayed and the failure message printed. The operator shall be able to use the CMT/R keyboard to perform system diagnostics down to the subsystem level to determine the cause of the failure message.

(g) The CMT/R shall store all data generated by the CPU on a storage medium. The CMT/R shall store a minimum of 15 days of data.

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In the event more than one CMT/R is installed with one system, the operator shall designate the active CMT/R.

controls, a block of user-definable keys and editing keys, and microprocessor interface. A minimum of six spare keys shall be available for future expansion of the system.

(c) Microprocessor - The microprocessor supplied for the CMT/R shall be the same unit used in the DPU and CPU processor design. The microprocessor shall be supplied with the operating software necessary to interface the CMT/R display, keyboard and DPU and CPU processor, display data formatting, display control, communications, and self-checks.

(d) Printer - The CMT/R shall interface directly with the CPU processor as specified in part 8, the CPU specification. Printer control shall be under the CMT/R. Printer commands issued by the operator using the CMT/R are transmitted by the CMT/R to the printer. The printer is specified in part 10 of this specification.

7-4. PERFORMANCE TESTS

7-4.1 Testing.- The contractor shall test the CMT/R *to* demonstrate that the unit meets the stated performance requirements. As a minimum, the CMT/R shall demonstrate the following:

(a) Use of the CMT/R to initialize the RVR, including clock reset, setting of the system constants,

(b) Display of current CPU products, output, and archived data.

(c) Manual data entry, rejection of erroneous inputs.

(d) RVR reconfiguration, including sensor activation/deactivation, change of system constants.

(e) Performance as an RMM station, including display and printout of failure messages, ability to acquire and display system status information.

(f) CPU and CMT/R communications link security and also detection and rejection of transmission errors.

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(e) Performance as an RMM station, including display and printout of failure messages, ability to acquire and display system status information.

(f) CPU and CMT/R communications link security and also detection and rejection of transmission errors.

8-3.2.2 Functions.- The following paragraphs describe the functional characteristics of the CPU.

8-3.2.2.1 Data reduction.- This function consists of processing of all DPU products. The CPU will separate and store DPU products for system diagnostics information. The contractor shall design quality control checks into the CPU data reduction software to ensure that the data received from the DPU is accurate, complete, and that the associated equipment is working properly.

8-3.2.2.2 Data processing.- The CPU shall implement the system algorithms and shall prepare the CPU products for dissemination in a digital format (ASCII code). Manual inputs received from the CMT/R shall be appended to the CPU products in the remarks area.

8-3.2.3 CPU products.- The CPU shall generate current system information on a regular basis. Current system information shall be a continuously updated product that is generated each minute containing current DPU products for all activated sensors, the date and time of day, remarks, and all RMM related output.

8-3.2.3.1 Product dissemination.- The CPU shall output its various products via the interface ports described in 8-3.2.5.1.

8-3.2.3.1.1 Automatic dissemination.- The CPU output shall be routed automatically to the RMMS and CMT/R for recordkeeping purposes.

8-3.2.3.1.2 Dissemination by inquiry.- The CPU output shall be routed to those output ports that feed equipment with a control input/data output capability only after an authorized operator has activated a control input (request) to the CPU from the CMT/R.

8-3.2.4 System control.- The CPU software shall permit the selection of the system control functions through use of the CMT/R. A menu of options shall be available for presentation on the CMT/R video display terminal. The CPU shall provide the control functions that will allow an operator: to initialize the system, to obtain reports that reflect the status of the RVR system, to modify the system, to edit any system product, and to control the output to a printer. These system control functions may be performed by on-site personnel or remotely via communications links. Passwords shall be used to limit access only to authorized users. System control functions include:

8-3.2.4.1 System initialization.- The following functions shall be performed when the system is initialized:

(a) Set time and date.

(b) Verification of system configuration.

(c) Perform system diagnostics.

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(4) Display device (on/off)

(5) External communications port

(b) Change system mode

(c) Change site-specific constants

(d) Delete (restore) any CPU product from (to) any or all output ports

8-3.2.4.4 Product editing.- This function allows an authorized technician to initiate or change any CPU product. A specific "editing" password shall control access to the editing function. Edited products shall include the initials of the editor (initials will not be disseminated with any CPU product but will be stored internally by the CPU). An authorized technician shall have the capability to:

(a) Prepare CPU products using the latest updated information.

(b) Prepare corrected CPU products, either from scratch or by editing a previously disseminated product still accessible in memory.

(c) Edit any CPU product (before release for dissemination) by override of data, cancellation of data, addition of new data, or cancellation of the entire product.

8-3.2.4.5 Maintenance diagnostic data.- A variety of information is required to facilitate the identification of system problems and/or failures. This information shall be available locally or remotely through authorized access to the appropriate output port. The contractor shall design appropriate means to meet the maintenance requirements of the system and submit the design for Government approval.

8-3.2.5 Hardware.- In order to accomplish the above functions, the CPU shall satisfy the following hardware requirements:

8-3.2.5.1 Interface ports.- Interface ports shall be asynchronous serial RS-449/232C compatible ports. The functions and the characteristics of each port are at Table 8-1. The product format shall be the same ASCII format for all output ports. Where differing display formats are required, the display shall be programmed to reformat the data.

(a) Data input

12 inputs for DPU's

1 input for CMT/R (serial ASCII)

2 spares (serial ASCII)

(4) Display device (on/off)

(5) External communications port

(b) Change system mode

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12 inputs for DPU's

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8-3.2.5.2 Memory.- For future growth, the CPU shall contain 50 percent more memory than necessary to accomplish the requirements of this specification. The CPU shall contain three types of memory:

(a) The EPROM shall contain all CPU programs, default system parameters, algorithm constants, and the software version number.

(b) The RAM shall contain the variable sensor parameters; status; and configuration, archived data, and maintenance information. This memory shall be protected with a rechargable battery source capable of retaining the memory for a period of 2 hours.

(c) Current data input from the sensors and CPU calculations shall be stored in a RAM.

8-3.2.5.3 Real time clock.- Greenwich Mean Time (GMT) shall be a product of the CPU. Days, hours, and minutes shall be provided as a system output for use in system displays. The day shall be expressed in the Julian Calendar (days of the year). Hours and minutes shall be indicated numerically from 0001 to 2400. The clock function shall be accurate within 30 seconds a year. It shall be capable of adjustment from the CMT/R to the correct (within 1 second) time. The clock function shall have a battery power source to maintain real time in the event of an AC primary power failure for a period of 30 days.

8-3.2.5.4 Processor(s).- Enough processing power in the CPU must be available to meet all specified functions with 50 percent excess in processing time. The processor shall have the capability to double the processing rate (for test purposes); therefore, all algorithm processing shall be accomplished when data input rates are doubled.

The following response times shall be achieved:

(a) CPU product processing: time less than 3 seconds.

(b) Modem/RMM response time: less than 3 seconds to begin the transmission, regardless of the time requested.

(c) The digital data response time shall be less than 5 seconds to begin the transmission. It shall include the time required to load a peripheral data buffer (in a CRT display monitor, for example) with data from the CPU and for a formatted display to appear.

8-3.2.6 Software/firmware.- The standards for development of the CPU software/firmware presented herein are mandatory requirements for the contractor to fulfill. However, the Government welcomes and will review any alternative(s) recommended by the contractor that better accomplishes the desired result. If the Government approves, the alternative may be substituted.

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Cable/Complete sensor failure

Sensor power supplies out of spec

Mechanical failure

Lamp failure

(b) Sampling Rate - The sensor sampling rate shall be controlled by the RDCI controller and shall be adjusted to meet the data processing needs of each sensor.

(c) Data Formatting - The RDCI shall combine the digitized analog and digital sensor output signals and other RDCI data into a single serial 1200/2400 baud data stream. The data format shall uniquely identify each data source.

(d) RDCI Controller - Operation of the converters, data formatting, and transmission shall be under control of a RDCI controller. In case of a power failure or any other disruption of the RDCI operation, the controller shall be automatically reset in order to properly reinitialize the RDCI operations.

(e) RMM - The RDCI shall monitor the outputs from all AC and DC power sources, the RDCI enclosure temperature, operation of fans and heaters (if any). The RDCI shall contain circuitry necessary to monitor the functions of the various sensors. The resulting analog and/or digital RMM signals shall be included in the RDCI serial output data.

(f) Power Monitoring and Power Reset - The RDCI shall constantly monitor all AC and DC power sources. If any output exceeds limits which could result in component damage, the source is either clamped or disconnected. When the output returns to normal, it is automatically reconnected. The power monitoring circuit operates from a trickle-charged battery in order to insure uninterrupted power for two hours.

(g) EMI/RFI Protection - The RDCI shall contain transient suppression devices on all input and output lines. The RDCI shall provide protection against EMI/RFI induced interference,

(h) Data Transmission - The RDCI shall transmit the data to the DPU using a data protocol which shall enable the receiving unit to detect transmission errors. The RDCI shall contain any required modems. See 3-3.2.1.5 and 3-3.2.1.6 for additional data transmission requirments.

(i) Data Redundancy - The RDCI shall contain provisions for inclusion of A/D converters, modems, and any associated circuits required to provide it with the capability to generate two independent streams as a means to enhance the system's reliability.

9-4. PERFORMANCE TESTS

9-4.1 RDCI Testing, - The RDCI tests shall demonstrate that the unit meets the stated design requirements for the full range of environmental conditions by demonstrating as a minimum compliance with the following design requirements:

(a) Proper scanning of all programmed channels at each selected channel sampling rate.

(b) A/D converter accuracy.

(c) Lack of channel interaction.

(d) Maintenance of output data format.

(e) Accurate output of all RMM quantities.

(f) Proper operation of environmental controls.

(g) Proper operation of transient arrestors, overvoltage protection circuits, and automatic reset.

(h) Automatic reinitialization after a failure.

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(e) Accurate output of all RMM quantities.

(f) Proper operation of environmental controls.

(g) Proper operation of transient arrestors, overvoltage protection circuits, and automatic reset.

(h) Automatic reinitialization after a failure.

This RVR algorithm differs from current United States practice in two ways in order to achieve better compatibility with ICAO standards:

1) The contrast threshold is reduced from 5.5 to 5.0 percent.

2) Four rather than two background luminance values are used.

The visibility break points based on this algorithm are shown in the attached table.

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TABLE 3-I

RVR REPORTING VALUES
BREAKPOINT EXTINCTION COEFFICIENT

REPORTING VALUE (Feet)	BREAK POINT (Feet)	NIGHT			TWILIGHT			DAY			BRIGHTDAY			
		LS3	LS4	LS5	LS3	LS4	LS5	LS3	LS4	LS5	LS3	LS4	LS5	LS2
100														
	150	256.50	291.70	326.91	170.94	206.14	241.34	120.57	155.78	190.98	99.68	134.88	170.08	69.43
200														
	250	140.49	161.61	182.74	89.15	110.28	131.40	58.94	80.06	101.18	46.40	67.52	88.64	58.06
300														
	350	94.04	109.13	124.22	67.37	72.46	87.55	35.79	50.88	65.96	27.18	41.92	57.01	27.18
400														
	450	69.48	81.22	92.95	40.95	52.69	64.43	24.17	35.91	47.64	21.14	28.94	40.67	21.14
500														
	550	54.45	64.05	73.66	31.12	40.72	50.32	17.38	26.98	36.58	17.30	21.28	30.88	17.30
600														
	650	44.98	63.11	61.23	25.24	33.36	41.49	14.64	21.74	29.86	14.64	16.92	25.04	14.64
700														
	750	38.61	45.65	52.69	21.60	28.54	35.58	12.69	18.47	25.51	12.69	14.29	21.33	12.69
800														
	900	31.73	37.59	43.46	17.47	23.33	29.20	10.57	14.94	20.81	10.57	11.46	17.32	10.57
1000														
	1100	25.16	20.96	34.76	13.49	18.29	23.09	8.65	11.42	16.22	8.65	8.65	13.37	8.45
1200														
	1300	20.45	24.51	28.57	10.57	14.63	18.70	7.32	8.82	12.89	7.32	7.32	10.47	7.32
1400														
	1500	17.09	20.61	24.13	8.54	12.06	15.58	6.34	7.02	10.54	6.34	6.34	8.45	6.34
1600														
	1700	14.60	17.71	20.81	7.05	10.16	13.26	5.60	5.71	8.82	5.60	5.60	6.97	5.60
1800														
	1900	12.68	15.46	18.24	5.92	8.70	11.48	5.01	5.01	7.61	5.01	5.01	5.86	5.01
2000														
	2100	11.16	13.67	16.19	5.05	7.56	10.08	4.53	4.53	6.48	4.63	4.53	4.99	4.59
2200														
	2300	9.93	12.22	14.52	4.35	6.64	8.94	4.14	4.14	5.66	4.14	4.14	4.29	4.14
2400														
	2500	8.92	11.03	13.14	3.81	5.89	8.01	3.81	3.81	4.98	3.81	3.81	3.81	3.81
2600														
	2700	8.07	10.02	11.98	3.52	5.27	7.23	3.52	3.52	4.43	3.52	3.52	3.52	3.52
2800														
	2900	7.35	9.17	10.99	3.28	4.74	6.57	3.28	3.28	3.96	3.28	3.28	3.28	3.26
3000														
	3250	6.33	7.95	9.58	2.93	4.00	5.63	2.93	2.93	3.30	2.93	2.93	2.93	2.93
3500														
	3750	5.23	6.64	8.05	2.54	3.22	4.63	2.54	2.54	2.61	2.54	2.54	2.54	2.54
4000														
	4250	4.43	5.67	6.91	2.24	2.65	3.89	2.24	2.24	2.24	2.24	2.24	2.24	2.24
4500														
	4750	3.81	4.92	6.03	2.00	2.22	3.33	2.00	2.00	2.00	2.00	2.00	2.00	2.00
5000														
	5250	3.32	4.32	5.33	1.81	1.88	2.88	1.81	1.81	1.81	1.81	1.81	1.81	1.81
5500														
	5750	2.93	3.84	4.76	1.65	2.53	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65
6000														
	6250	2.60	3.45	4.29	1.52	1.52	2.24	1.52	1.52	1.52	1.52	1.52	1.52	1.32
6500														

NOTE: Equations are done in Metric

TABLE 3-I

RVR REPORTING VALUES
BREAKPOINT EXTINCTION COEFFICIENT

REPORTING VALUE (Feet)	BREAK POINT (Feet)	NIGHT			TWILIGHT			DAY			BRIGHTDAY			
		LS3	LS4	LS5	LS3	LS4	LS5	LS3	LS4	LS5	LS3	LS4	LS5	LS2
100														
	150	256.50	291.70	326.91	170.94	206.14	241.34	120.57	155.78	190.98	99.68	134.88	170.08	69.43
200														
	250	140.49	161.61	182.74	89.15	110.28	131.40	58.94	80.06	101.18	46.40	67.52	88.64	58.06
300														
	350	94.04	109.13	124.22	67.37	72.46	87.55	35.79	50.88	65.96	27.18	41.92	57.01	27.18
400														
	450	69.48	81.22	92.95	40.95	52.69	64.43	24.17	35.91	47.64	21.14	28.94	40.67	21.14
500														
	550	54.45	64.05	73.66	31.12	40.72	50.32	17.38	26.98	36.58	17.30	21.28	30.88	17.30
600														
	650	44.98	63.11	61.23	25.24	33.36	41.49	14.64	21.74	29.86	14.64	16.92	25.04	14.64
700														
	750	38.61	45.65	52.69	21.60	28.54	35.58	12.69	18.47	25.51	12.69	14.29	21.33	12.69
800														
	900	31.73	37.59	43.46	17.47	23.33	29.20	10.57	14.94	20.81	10.57	11.46	17.32	10.57
1000														
	1100	25.16	20.96	34.76	13.49	18.29	23.09	8.65	11.42	16.22	8.65	8.65	13.37	8.45
1200														
	1300	20.45	24.51	28.57	10.57	14.63	18.70	7.32	8.82	12.89	7.32	7.32	10.47	7.32
1400														
	1500	17.09	20.61	24.13	8.54	12.06	15.58	6.34	7.02	10.54	6.34	6.34	8.45	6.34
1600														
	1700	14.60	17.71	20.81	7.05	10.16	13.26	5.60	5.71	8.82	5.60	5.60	6.97	5.60
1800														
	1900	12.68	15.46	18.24	5.92	8.70	11.48	5.01	5.01	7.61	5.01	5.01	5.86	5.01
2000														
	2100	11.16	13.67	16.19	5.05	7.56	10.08	4.53	4.53	6.48	4.63	4.53	4.99	4.59
2200														
	2300	9.93	12.22	14.52	4.35	6.64	8.94	4.14	4.14	5.66	4.14	4.14	4.29	4.14
2400														
	2500	8.92	11.03	13.14	3.81	5.89	8.01	3.81	3.81	4.98	3.81	3.81	3.81	3.81
2600														
	2700	8.07	10.02	11.98	3.52	5.27	7.23	3.52	3.52	4.43	3.52	3.52	3.52	3.52
2800														
	2900	7.35	9.17	10.99	3.28	4.74	6.57	3.28	3.28	3.96	3.28	3.28	3.28	3.26
3000														
	3250	6.33	7.95	9.58	2.93	4.00	5.63	2.93	2.93	3.30	2.93	2.93	2.93	2.93
3500														
	3750	5.23	6.64	8.05	2.54	3.22	4.63	2.54	2.54	2.61	2.54	2.54	2.54	2.54
4000														
	4250	4.43	5.67	6.91	2.24	2.65	3.89	2.24	2.24	2.24	2.24	2.24	2.24	2.24
4500														
	4750	3.81	4.92	6.03	2.00	2.22	3.33	2.00	2.00	2.00	2.00	2.00	2.00	2.00
5000														
	5250	3.32	4.32	5.33	1.81	1.88	2.88	1.81	1.81	1.81	1.81	1.81	1.81	1.81
5500														
	5750	2.93	3.84	4.76	1.65	2.53	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65
6000														
	6250	2.60	3.45	4.29	1.52	1.52	2.24	1.52	1.52	1.52	1.52	1.52	1.52	1.32
6500														

NOTE: Equations are done in Metric

TABLE 3-I

RVR REPORTING VALUES
BREAKPOINT EXTINCTION COEFFICIENT

REPORTING VALUE (Feet)	BREAK POINT (Feet)	NIGHT			TWILIGHT			DAY			BRIGHTDAY			
		LS3	LS4	LS5	LS3	LS4	LS5	LS3	LS4	LS5	LS3	LS4	LS5	LS2
100														
	150	256.50	291.70	326.91	170.94	206.14	241.34	120.57	155.78	190.98	99.68	134.88	170.08	69.43
200														
	250	140.49	161.61	182.74	89.15	110.28	131.40	58.94	80.06	101.18	46.40	67.52	88.64	58.06
300														
	350	94.04	109.13	124.22	67.37	72.46	87.55	35.79	50.88	65.96	27.18	41.92	57.01	27.18
400														
	450	69.48	81.22	92.95	40.95	52.69	64.43	24.17	35.91	47.64	21.14	28.94	40.67	21.14
500														
	550	54.45	64.05	73.66	31.12	40.72	50.32	17.38	26.98	36.58	17.30	21.28	30.88	17.30
600														
	650	44.98	63.11	61.23	25.24	33.36	41.49	14.64	21.74	29.86	14.64	16.92	25.04	14.64
700														
	750	38.61	45.65	52.69	21.60	28.54	35.58	12.69	18.47	25.51	12.69	14.29	21.33	12.69
800														
	900	31.73	37.59	43.46	17.47	23.33	29.20	10.57	14.94	20.81	10.57	11.46	17.32	10.57
1000														
	1100	25.16	20.96	34.76	13.49	18.29	23.09	8.65	11.42	16.22	8.65	8.65	13.37	8.45
1200														
	1300	20.45	24.51	28.57	10.57	14.63	18.70	7.32	8.82	12.89	7.32	7.32	10.47	7.32
1400														
	1500	17.09	20.61	24.13	8.54	12.06	15.58	6.34	7.02	10.54	6.34	6.34	8.45	6.34
1600														
	1700	14.60	17.71	20.81	7.05	10.16	13.26	5.60	5.71	8.82	5.60	5.60	6.97	5.60
1800														
	1900	12.68	15.46	18.24	5.92	8.70	11.48	5.01	5.01	7.61	5.01	5.01	5.86	5.01
2000														
	2100	11.16	13.67	16.19	5.05	7.56	10.08	4.53	4.53	6.48	4.63	4.53	4.99	4.59
2200														
	2300	9.93	12.22	14.52	4.35	6.64	8.94	4.14	4.14	5.66	4.14	4.14	4.29	4.14
2400														
	2500	8.92	11.03	13.14	3.81	5.89	8.01	3.81	3.81	4.98	3.81	3.81	3.81	3.81
2600														
	2700	8.07	10.02	11.98	3.52	5.27	7.23	3.52	3.52	4.43	3.52	3.52	3.52	3.52
2800														
	2900	7.35	9.17	10.99	3.28	4.74	6.57	3.28	3.28	3.96	3.28	3.28	3.28	3.26
3000														
	3250	6.33	7.95	9.58	2.93	4.00	5.63	2.93	2.93	3.30	2.93	2.93	2.93	2.93
3500														
	3750	5.23	6.64	8.05	2.54	3.22	4.63	2.54	2.54	2.61	2.54	2.54	2.54	2.54
4000														
	4250	4.43	5.67	6.91	2.24	2.65	3.89	2.24	2.24	2.24	2.24	2.24	2.24	2.24
4500														
	4750	3.81	4.92	6.03	2.00	2.22	3.33	2.00	2.00	2.00	2.00	2.00	2.00	2.00
5000														
	5250	3.32	4.32	5.33	1.81	1.88	2.88	1.81	1.81	1.81	1.81	1.81	1.81	1.81
5500														
	5750	2.93	3.84	4.76	1.65	2.53	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65
6000														
	6250	2.60	3.45	4.29	1.52	1.52	2.24	1.52	1.52	1.52	1.52	1.52	1.52	1.32
6500														

NOTE: Equations are done in Metric

FAA-E-2269b
January 30, 1984
SUPERSEDING
FAA-E-2269a
August 21, 1969

DEPARTMENT Of TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SPECIFICATION

RUNWAY VISUAL RANGE SYSTEM